

**DRAFT FINAL
GROUP X4B(u) SITE SPECIFIC WORK PLAN
(RSA-66 AND RSA-68)**

REDSTONE ARSENAL, ALABAMA

DACA87-95-D-0018

TASK ORDER 0005

**PREPARED FOR
U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER**

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SEPTEMBER 1996

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
BRA	Baseline Risk Assessment
CEHNC	U.S. Army Corps of Engineers, Huntsville Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory
COPCs	Chemicals of Potential Concern
CPSS	Chemicals Present in Site Samples
CSM	Conceptual Site Model
DQOs	Data Quality Objectives
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering, Inc.
FS	Feasibility Study
HHRA	Human Health Risk Assessment
IDW	Investigation-Derived Waste
IRFNA	Inhibited Red Fuming Nitric Acid
MCLs	Maximum Concentration Limits
PAHs	Polycyclic Aromatic Hydrocarbons
PELA	P.E. LaMoreaux and Associates
QC	Quality Control
RBC	Risk-Based Concentrations
RI	Remedial Investigation

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RME	Reasonable Maximum Exposure
RSA	Redstone Arsenal
SAP	Sampling Analysis Plan
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SWMUs	Solid Waste Management Units
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TOC	Total Organic Compound
USEPA	US Environmental Protection Agency
VOCs	Volatile Organic Compounds

SECTION 1

INTRODUCTION

1.0.a This document was prepared by Parsons Engineering Science of Atlanta, Georgia, for the U.S. Army Corps of Engineers, Huntsville Center (CEHNC), Huntsville, Alabama. The preparation of this document was conducted under Task Order 0005 of Contract No. DACA87-95-D-0018.

1.1 PURPOSE OF REPORT

1.1.a This document presents site-specific information concerning Sites RSA-66 and RSA-68, also referred to as Group X4B(u), at Redstone Arsenal (RSA). This document also identifies specific requirements for the RI/FS activities to be conducted at these sites. General information applicable to all RSA sites is presented in the General RI/FS Work Plan (Parsons ES, 1996).

1.2 REPORT ORGANIZATION

1.2.a Conditions at Sites RSA-66 and RSA-68 are presented in Section 2. Section 3 presents the conceptual site models (CSMs). Remedial technologies that are potentially applicable at these sites, the preliminary identification of applicable or relevant and appropriate requirements (ARARs), and data quality objectives are also discussed in Section 3. The RI task plan, including requirements for pre-field activities, field investigations, data reduction, baseline risk assessments, and data reporting, is presented in Section 4. The feasibility study (FS) methodology is presented in Section 5. Requirements for plans and project management are discussed in Section 6. References cited in this document are listed in Section 7. Appendices to this document include the Site-Specific Safety and Health Plan, the Field Sampling Plan, and the Chemical Data Acquisition Plan.

1.3 PROJECT PERSONNEL

1.3.a The following Parsons ES personnel provided significant contributions to the preparation of this document:

- Thomas M. Roth, P.E. Project Manager
- Kenneth J. Stockwell, P.E. Technical Director

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Group X4B(u)
Site Specific Work Plan
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- Cindy Lewis Health and Safety
- Karen Scruton Risk Assessment
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SECTION 2

SITE CONDITIONS

2.0.a This section presents background information on Sites RSA-66 (Area X1) and RSA-68 (Area Z), referred to collectively as Group X4B(u), and describes the physical setting of these sites. Regional and facility information is presented in the Generic RI/FS Work Plan (Parsons ES, 1996).

2.1 SITE BACKGROUND

2.1.a Group X4B(u) is located in the southern part of RSA and is comprised of two SWMUs, RSA-66 and RSA-68 (Figure 2-1). Group X4B(u) is located on the flood plain 1700 feet east of the Tennessee River, 1800 feet north of the open burn/open detonation area of Unit 2, and directly north of Area Y, a former storage area for mustard gas.

2.1.1 RSA-66 (Former Testing and Ash Disposal Area)

2.1.1.a RSA-66, also known as Area X1 is located in the western part of Group X4B(u) (Figure 2-2). It is located north of Unit 2 and west of RSA-68. The land surface at RSA-66 is relatively flat with poorly developed drainage patterns. Small ponds and wetlands cover northern parts of RSA-66. The eastern half of the SWMU is covered with grasses, and the western half is wooded.

2.1.1.b RSA-66 is a closed unlined waste disposal and demolition area located within a one-half mile of the Tennessee River. It is approximately two acres. The landfill portion of the site was active from the 1950s to the late 1970s, and was used as a disposal area for incineration ash, residue, and un-salvageable metal debris (e.g., rocket motor parts, crushed drums) from the open burning operations at the OB/OD grounds (RSA-13 and 14). Detonation lines and small bunkers indicate that about six acres of the site was used for demilitarization and demolition of munitions. This would support the mission of the Gulf Chemical Warfare Depot in the mid to late 1940s.

2.1.1.c RSA-66 was used during the 1950s through the 1970s to dispose of ash, residue, and debris from open burning of wastes at Unit 2. According to reports (PELA, 1988, and G&M, 1992) and sources at RSA (Bill Schroder, 1989, personal communication), disposal operations apparently were confined to the eastern part of the site; waste is now mostly covered by soil, grass, and weeds. Drums, bottles of

unidentified chemicals, and ordnance were observed on the land surface during site visits (G&M, 1992). Mustard gas test kits were discovered during surveying operations. In addition, there is evidence on site, including a safety shower, old detonation lines, and bunkers, to indicate that open detonation may have occurred at RSA-66 in the past. During a site visit by Parsons ES personnel (April 24 and 25, 1996) it was observed that the 2 acre Former Ash Disposal Area, located in the southeastern quadrant of RSA-66, had been planted with rye grass.

2.1.2 RSA-68 (Former Industrial Waste Landfill)

2.1.2.a RSA-68, also known as Area Z, occupies approximately 5 acres (Figure 2-3) and is located in the eastern part of Group X4B(u). It is located immediately north of Unit Y (former storage area for mustard gas), east of RSA-66, and east of the Tennessee River. RSA-68 is bounded on the west by a low-lying forested area, the "Igloo" ponds, and associated drainage ditches. The topography of RSA-68 is nearly flat with surface drainage controlled by drainage ditches west and east of the site and wetlands to the north. Vegetation at the site consists primarily of grasses, briars, and small pines.

2.1.2.b A large variety of items and wastes were demilitarized, treated and disposed of at this site. This area was formerly known as Toxic Area 4 within the Gulf Chemical Warfare Depot during the 1940s. Presently, the site is covered with grasses, briars, and pine trees. The vegetation is sparse and is stressed. The site was used as a demilitarization area for explosives during the mid to late 1940s. During the 1950s to 1980, the site was active as a disposal area for toxic waste and laboratory chemicals. RSA-68 is located in the southern part of RSA within the floodplain of the Tennessee River, west of Igloo Pond and south of Buxton Road. Portions of the site along the north and west boundaries are submerged and marshy. Toxic chemicals, including, beryllium, inhibited red fuming nitric acid (IRFNA), chlorine trifluoride, laboratory wastes, high explosives, and various other chemicals were disposed of at this unit. High explosives were detonated and burned on bare ground; nitric acid was neutralized in open pits lined with crushed limestone; and other wastes were disposed of in trenches located in this area. The chlorine trifluoride was neutralized in a pit using sodium bicarbonate. Reports by PELA (1988b and 1989) list the following chemicals reportedly disposed at RSA-68:

Ammonia	Dichlorofluoromethane	Iodine
Ammonia, anhydrous	Dimethyl ether	Pentofluoride
Boron trichloride	Ethane	Methyl acetylene
Butadiene	Ethylene	Nitric oxide
Butane	Freon-23 (fluoroform)	Nitrogen dioxide
N-butane	Freon	Nitrous oxide
Butene-ICP	Hydrogen	Propylene
Carbonyl sulfide	Chlorine, anhydrous	Phosphine

Cyclopropane	Hydrogen fluoride	Phosgene
Chlorotrifluoromethane	Hydrogen sulfide	Sulfur dioxide
Chlorine	Isobutylene	Sulfur dioxide trimethylamine
Chlorine trifluoride	Isobutylene CP Grade	Triethylaluminum
Cyclopropane		Vinyl chloride

2.1.2.c On October 10, 1990, G&M personnel located buried ordnance while conducting test pit operations at RSA-68 (G&M, 1992). The following items were identified by local Explosive Ordnance Disposal personnel:

- one 100 lb chemical bomb,
- one 105 mm warhead,
- one anti-tank warhead or rifle grenade,
- five 105 mm rockets,
- one 57 mm warhead,
- one 105 mm projectile, and
- many metal containers for the storage of chemicals (memorandum for AMSMI-RA from Todd Hutto, October 12, 1990).

2.2 PHYSICAL SETTING

2.2.a The topography and surface features of RSA-66 and RSA-68 are described below.

2.2.1 RSA-66 (Former Testing and Ash Disposal Area)

2.2.1.a The land surface at RSA-66 is nearly flat with surface elevations ranging from approximately 566 ft msl on the northern edge of the site to just over 570 on the southwest corner of the site. Small ponds and wetlands cover most of RSA-66 and drainage is poor. The site is heavily wooded, with the exception of the former ash disposal area, which is now an open field covered with grasses.

2.2.2 RSA-68 (Former Industrial Waste Landfill)

2.2.2.a The land surface at RSA-68 is nearly flat with surface elevations throughout the site approximately 565 ft msl. Drainage at the site is controlled by southward-flowing drainage ditches west and east of the site and wetland areas to the north. The site is covered with trees and other vegetation.

2.3 GEOLOGY

2.3.a The geologic settings of RSA-66 and RSA-68 are described below.

2.3.1 Regional Geologic Setting

2.3.1.a A discussion of the regional geologic setting is provided in the Generic RI/FS Work Plan (Parsons ES, 1996).

2.3.2 RSA-66 (Former Testing and Ash Disposal Area)

2.3.2.a The overburden at RSA-66 consists of alluvial deposits of the Tennessee River including sandy clay, clayey sand, and sand. Surficial sandy-clay deposits range in thickness from 10 to 25 feet. Beneath the surficial sandy clay, deposits coarsen downward to poorly-sorted, sand with random occurrences of gravel. The total thickness of the overburden at RSA-66 ranges from 27 feet to 65 feet (PELA, 1988). The bedrock unit, the Tuscumbia Limestone ranges from 514 ft msl in the southern portion of the site to 539 ft msl in the west. Well-construction data indicate the surface elevation of the Tuscumbia Limestone is variable with two local structural highs at RS316 and RS205 (Figure 2-4).

2.3.3 RSA-68 (Former Industrial Waste Landfill)

2.3.3.a The overburden at RSA-68 consists of surficial sandy-clay deposits with grain size increasing with depth to silty, clayey, coarse-grained sand and gravel near the base of the overburden. The thickness of the overburden ranges from 10 to 62 feet across the site (G&M, 1993). The bedrock unit is the Tuscumbia Limestone. A weathered limestone surface is sometimes present at the top of the bedrock at RSA-68.

2.4 HYDROGEOLOGY

2.4.a The hydrogeologic settings of RSA-66 and RSA-68 are described below.

2.4.1 Regional Hydrogeologic Setting

2.4.1.a A discussion of the regional hydrogeologic setting is provided in the Generic RI/FS Work Plan (Parsons ES, 1996).

2.4.2 RSA-66 (Former Testing and Ash Disposal Area)

2.4.2.a A hydrogeologic profile across RSA-66 is presented in Figure 2-4. Three distinct hydrogeologic zones were determined for the area: (1) the alluvial overburden; (2) the upper strata of the weathered Tuscumbia Limestone; (3) fracture zones and cavities in the deeper bedrock of the Tuscumbia Limestone (G&M, 1993) (not shown on Figure 2-4).

2.4.2.b Depths to water in wells screened in the overburden aquifer range from 3.45 ft in RS143 to 9.60 ft in RS204 (G&M, 1993). Hydraulic head elevations within the overburden aquifer are shown in Figure 2-5. Hydraulic conductivities have an order of

magnitude of 10^{-4} cm/sec. Groundwater movement is generally west towards the Tennessee River.

2.4.2.c Little information is available about the bedrock aquifers at RSA-66. Depths to water in wells screened in the upper bedrock aquifer range from 10.89 to 12.36 feet. Depth to water in the one well screened in the deep aquifer (RS380) was 12.24 feet (G&M, 1993). Hydraulic conductivities for the upper bedrock aquifer had an order of magnitude of 10^{-2} cm/sec while conductivities for the deep bedrock aquifer had an order of magnitude of 10^{-3} cm/sec.

2.4.3 RSA-68 (Former Industrial Waste Landfill)

2.4.3.a A hydrogeologic profile across RSA-68 is presented in Figure 2-6. Four distinct hydrogeologic zones were determined for the area: (1) a shallow water-bearing zone generally less than 10 feet deep in the shallow (upper) overburden; (2) a basal alluvial (deep) overburden zone consisting of sandy clay, coarse-grained sands, and gravels; (3) the upper weathered strata of the Tuscumbia Limestone; and (4) deep fractured and cavernous zones in the Tuscumbia Limestone (G&M, 1993).

2.4.3.b The water levels in the shallow overburden zone range in depth at RSA-68 from 2.46 ft in RS325 to 8.63 ft in RS1524. Water table elevations are shown in Figure 2-7. Groundwater appears to flow southwest toward wetlands and the Tennessee River.

2.4.3.c Depths to groundwater in wells screened in the basal alluvial overburden zone range from 3.07 ft in RS319 to 5.58 ft in RS043. Water levels within the deep overburden aquifer are shown in Figure 2-8. Groundwater flow is generally toward the wetlands south and west of the site, and towards the Tennessee River. Hydraulic conductivity in this aquifer has an order of magnitude of 10^{-4} cm/sec.

2.4.3.d Depths to groundwater in wells screened in the upper bedrock aquifer range from 7.80 ft in RS330 to 13.13 ft in RS226. Water levels within the upper bedrock aquifer are shown in Figure 2-9. Water-level data indicate that the direction of groundwater flow in this zone is toward the south-southwest. Depths to groundwater in wells screened in the deep bedrock aquifer range from 125 to 130 feet. Water levels within the deep bedrock aquifer are shown in Figure 2-10. Groundwater flow in the upper weathered strata and deeper zones of the Tuscumbia Limestone is primarily through cavities and solution-enlarged fractures. Hydraulic conductivities in the Tuscumbia Limestone at RSA-68 have an order of magnitude of 10^{-3} cm/sec.

2.5 RESULTS OF PREVIOUS INVESTIGATIONS

2.5.a Studies have been conducted at RSA-66 and RSA-68 and the results are summarized below.

2.5.1 Previous Investigations

2.5.1.a In 1986, PELA was contracted by CEHNC to perform RI/FS-type studies at 22 closed and abandoned SWMUs at Unit 3, including RSA-66 and RSA-68. The results of their investigation are included in a 1988 report entitled "Confirmation Report, Unit 3 Investigations, Redstone Arsenal, Alabama" (PELA, 1988a). The report includes soil/waste quality data, water-level and water-quality data, geologic logs and cross sections, and monitor well construction details. Additional studies at 11 of the sites (including RSA-66 and RSA-68) were recommended by PELA and authorized by the CEHNC.

2.5.1.b The results of PELA's subsequent investigation were submitted to CEHNC in a report entitled "Upgrade Confirmation Report and Assessment of Remedial Alternatives for Selected Unit 3 Sites, Redstone Arsenal, Alabama" (PELA, 1989). PELA (1989) concluded that soil and groundwater contamination as a result of disposal activities had occurred at RSA-56 and RSA-68. Elevated concentrations of metals and VOCs were detected in soil and groundwater samples. Soil/waste samples from the southern half of RSA-68 showed a variety of constituents of concern, including VOCs, metals, and pesticides. Metals and VOCs were detected in groundwater samples from the overburden and bedrock zones surrounding RSA-68. PELA (1989) recommended continuous monitoring and additional studies at both RSA-66 and RSA-68 to identify and characterize the sources of contamination and to assess the horizontal and vertical extent of contamination in both soil and groundwater at these SWMUs.

2.5.1.c Geraghty & Miller (G&M) was contracted by CEHNC in 1989 to perform RFIs for selected sites throughout RSA including RSA-66 and RSA-68. The results of the investigation are included in two reports, "Phase I Report RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas Redstone Arsenal, Alabama" (G&M, 1992) and "Final Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas Redstone Arsenal, Alabama" (G&M, 1993). Field activities at both SWMUs included geophysical surveying, test pit excavations, air monitoring, surface soil sampling, soil borings with subsurface soil sampling, sediment and surface water sampling, monitor well installation, and groundwater sampling. The results of the RFI for each site is described in detail below.

2.5.1.d No remediation has been conducted at Group X4B(u). After the discovery of the mustard gas kits and the ordnance during the RFI field investigations at RSA-66, the area was surface-cleared for ordnance, and access was restricted.

2.5.2 Results of Previous Investigations at RSA-66

2.5.2.a The scope of the RFI at RSA-66 was to address contamination related to the former ash and waste disposal activities at the site. Soil gas sampling, geophysical

surveying, test pit excavations, air monitoring, shallow and deep soil sampling, sediment and surface water sampling, monitor well installation and groundwater sampling were performed during Phases I and II of the RFI (G&M, 1993). The potential sources of contamination include the ash disposal landfill and the former open detonation areas.

2.5.2.b Results of groundwater sampling indicate that the most significant VOCs detected at the site were trichloroethene and associated chlorinated hydrocarbons. The highest concentrations of chlorinated hydrocarbons in the overburden zone were found approximately 100 ft downgradient of the outlined disposal area (Figure 2-2). Chlorinated hydrocarbons were present in all site wells located within 100 ft of the disposal area, and were detected only in trace amounts in other site wells.

2.5.2.c Chlorinated hydrocarbons were detected in the two upper bedrock wells and in the deep bedrock well. The vertical extent of contamination has not yet been determined at this site. Access limitations (wetlands) prevented installation of additional monitoring wells to determine the lateral extent of contamination in the bedrock aquifers.

2.5.2.d The most significant contaminants found in the soils at RSA-66 were trichloroethene and associated chlorinated hydrocarbons, metals, and PETN (an explosive) (G&M, 1993). Analysis of soil samples indicated contamination was mainly confined to the former ash disposal area. Samples collected from test pits within the former ash disposal area indicated high levels of chlorinated hydrocarbons and PETN. Outside of the former ash disposal area, however, the only contaminants detected were methylene chloride, trace levels of chlorinated hydrocarbons, and bis(2-ethylhexyl)phthalate. Surface water samples collected during the RFI were free of contaminants.

2.5.3 Results of Previous Investigations at RSA-68

2.5.3.a The RFI at RSA-68 investigated contamination related former disposal activities at the site. Soil gas sampling, geophysical surveying, test pit excavations, air monitoring, shallow and deep soil sampling, sediment and surface water sampling, monitor well installation and groundwater sampling were performed during Phases I and II of the RFI at RSA-68 (G&M, 1993). Sampling locations are presented in Figure 4-1. Sources of contamination at RSA-68 are the disposal trenches used to dispose of a variety of industrial wastes and chemicals. The contaminants found at RSA-68 are more diverse than at any other site at RSA studied by G&M (G&M, 1993).

2.5.3.b Results of groundwater sampling indicate that the most significant VOCs are chlorinated hydrocarbons (particularly trichloroethene) and explosives (HMX, RDX, and 1,3,5-trinitrobenzene), even though a wider variety of contaminants were detected in the soils. The extent of contamination in the overburden zones has been defined to the northeast, southeast and west of the site. Wetlands north of RSA-68 prevented the

installation of wells in that direction to characterize the lateral extent of groundwater contamination in the overburden.

2.5.3.c The areal extent of chlorinated hydrocarbons in the upper bedrock is well defined east and west of RSA-68. Access limitations prevented the installation of bedrock wells both north and south of RSA-68. Therefore, the extent of contaminants in the upper bedrock is undefined north and south of the suspected source. Chlorinated hydrocarbons were detected in all four deep bedrock wells, therefore neither the horizontal nor the vertical extent of contamination has been defined in the deep bedrock zone.

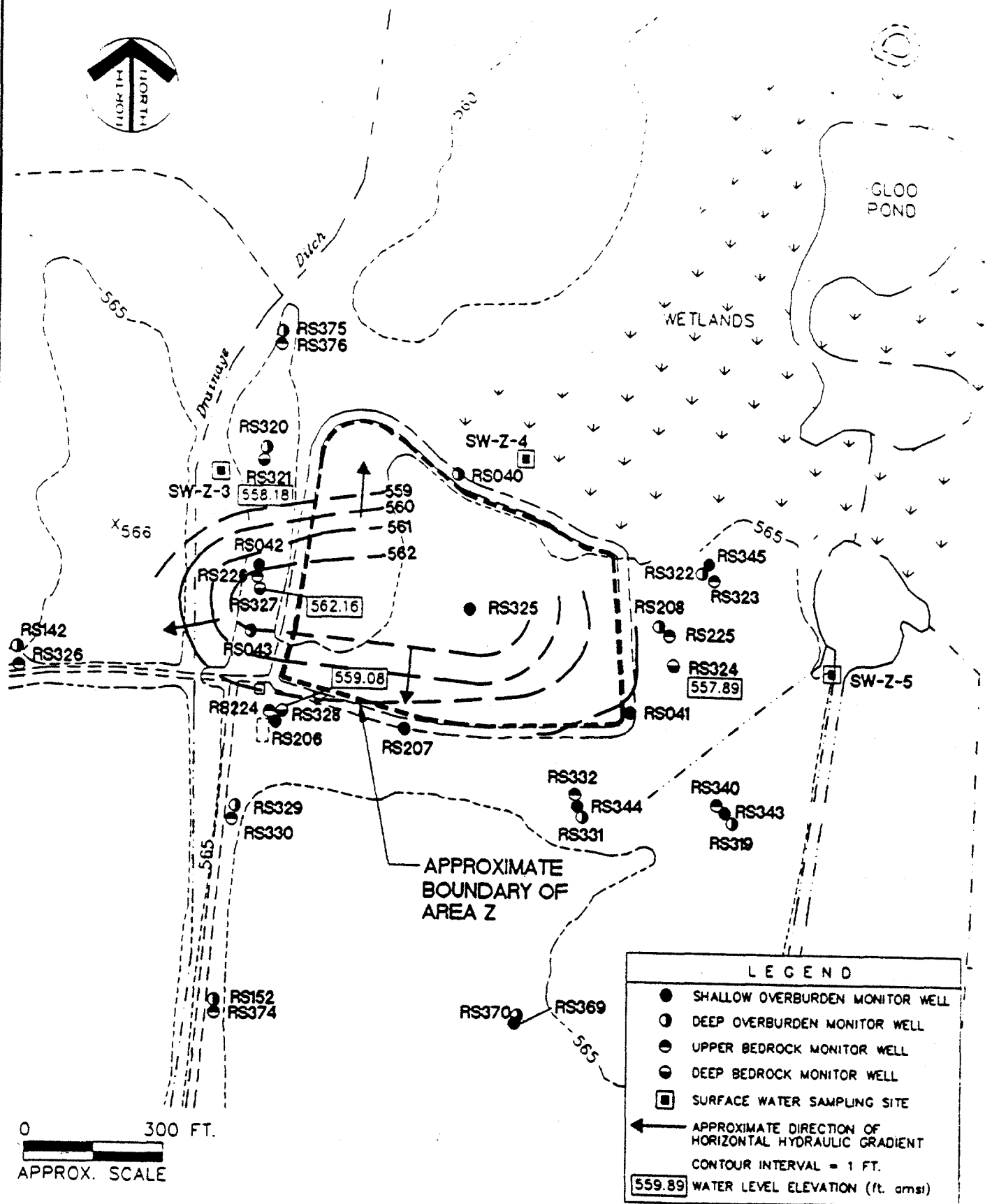
2.5.3.d Groundwater data collected by G&M (1993) defines the extent of explosives to be restricted the area beneath and in the immediate vicinity of RSA-68 and indicates that significant migration of explosive residues has not occurred.

2.5.3.e Many contaminants were detected at elevated levels in the soils and soil/wastes, including chlorinated hydrocarbons, VOCs, PAHs, metals, pesticides, and explosive residues. The extent of soil contamination appears to be contained within the boundary of RSA-68. Within RSA-68, the occurrence of specific constituents of concern is very localized. The constituents detected in the test pits varied widely from pit to pit and, in some cases, within the same pit. The occurrence of solid debris was also found to be localized within the boundaries of RSA-68. Test pits encountered metal waste and buried ordnance (canisters, shells, warheads, and chemical munitions) and obvious chemical staining. Outside the boundaries of RSA-68, only one soil/sediment sample contained contaminants, with relatively low concentrations of chlorinated hydrocarbons and organochlorine pesticides.

2.5.3.f Three surface water locations were sampled during the Phase I investigation. They had low concentrations of VOCs, metals and organochlorine pesticides indicating migration of contaminants into the surface water does not appear to be a major problem at RSA-68.

Figure 2-10

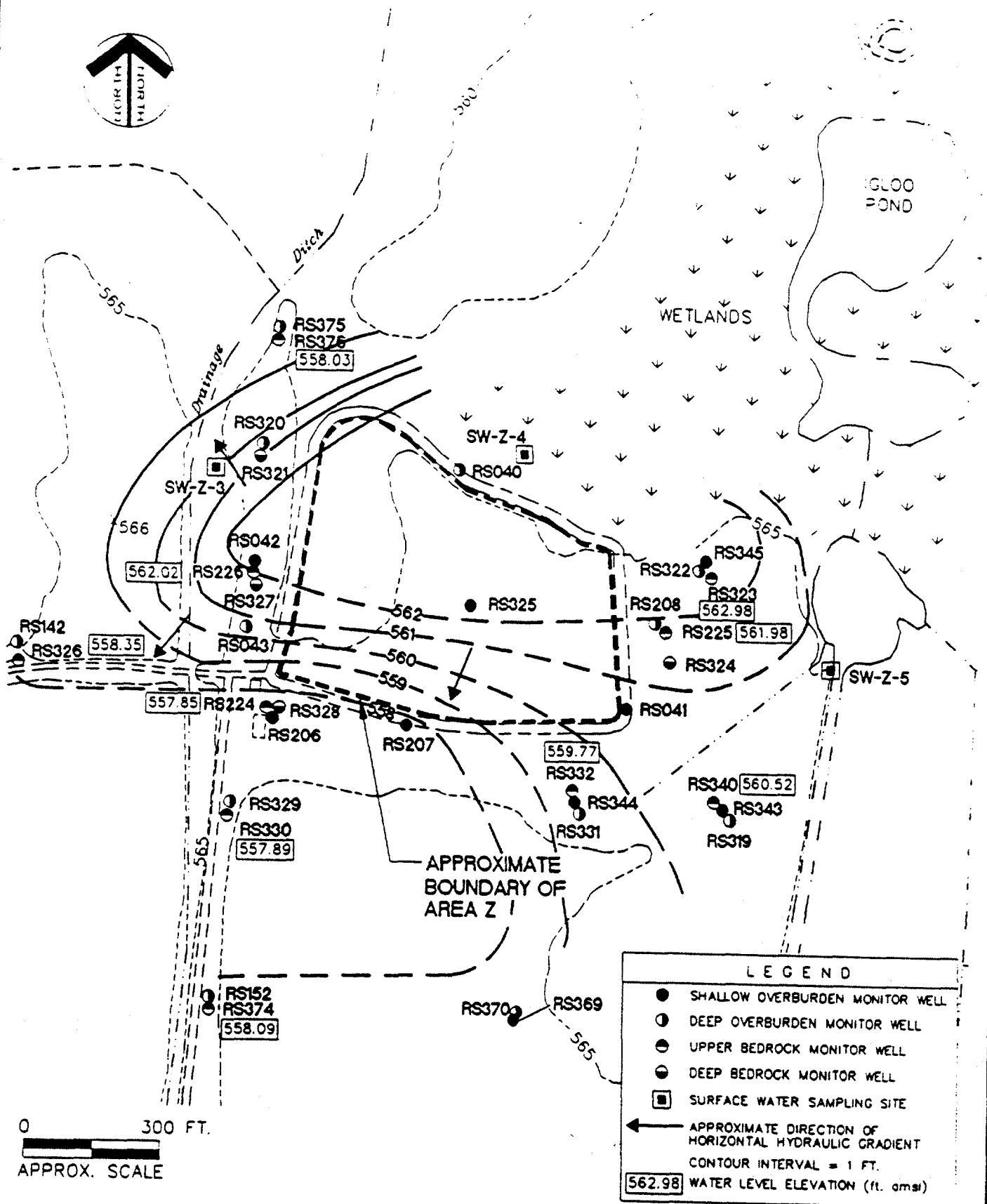
DEEP BEDROCK POTENTIOMETRIC SURFACE AT RSA-68 REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

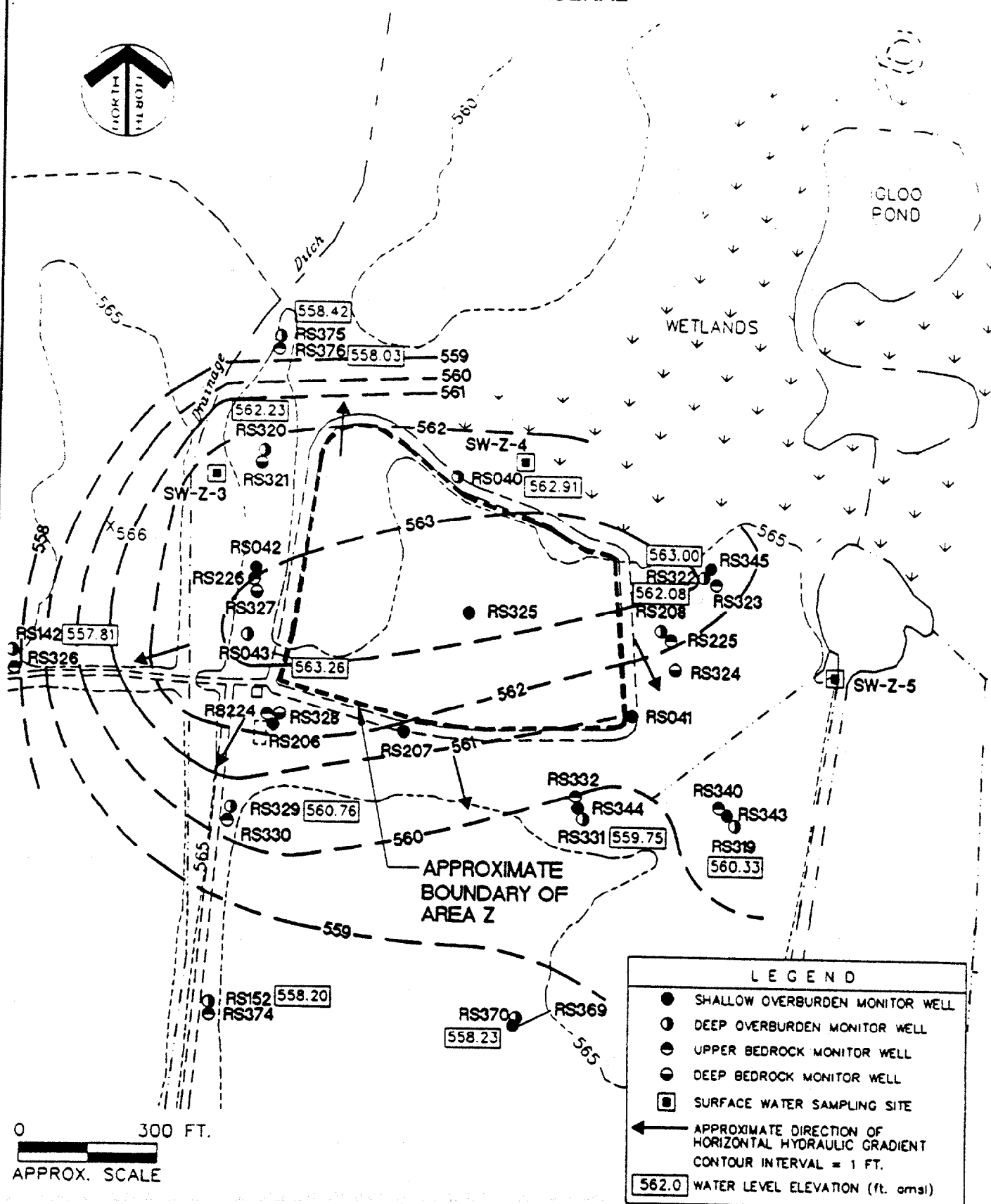
Figure 2-9

UPPER BEDROCK POTENTIOMETRIC SURFACE AT RSA-68 REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

DEEP OVERBURDEN POTENTIOMETRIC SURFACE AT SITE RSA-68 REDSTONE ARSENAL

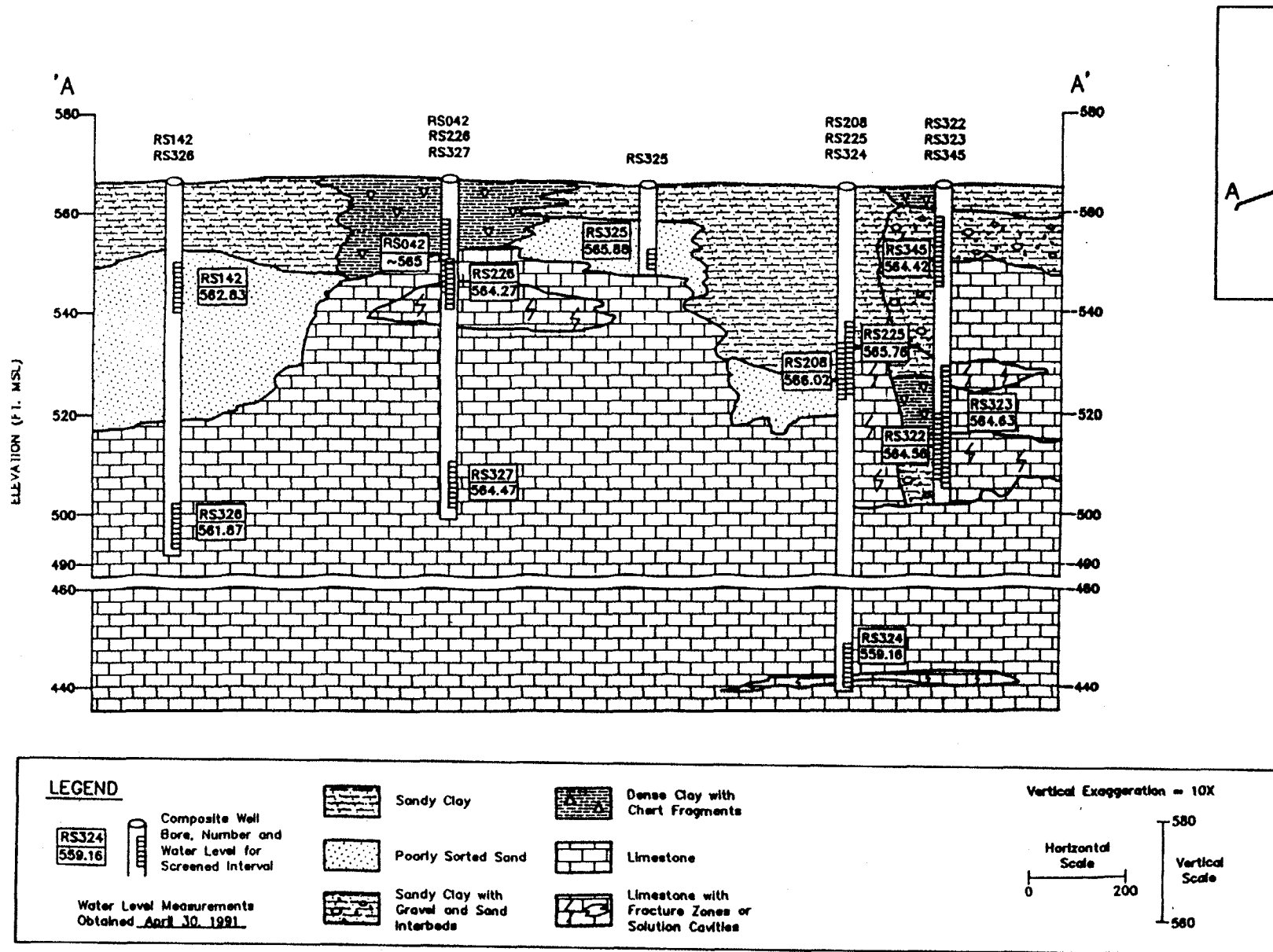


After Geraghty & Miller, Inc., 1993.

WATER TABLE SURFACE MAP AT SITE RSA-68 REDSTONE ARSENAL

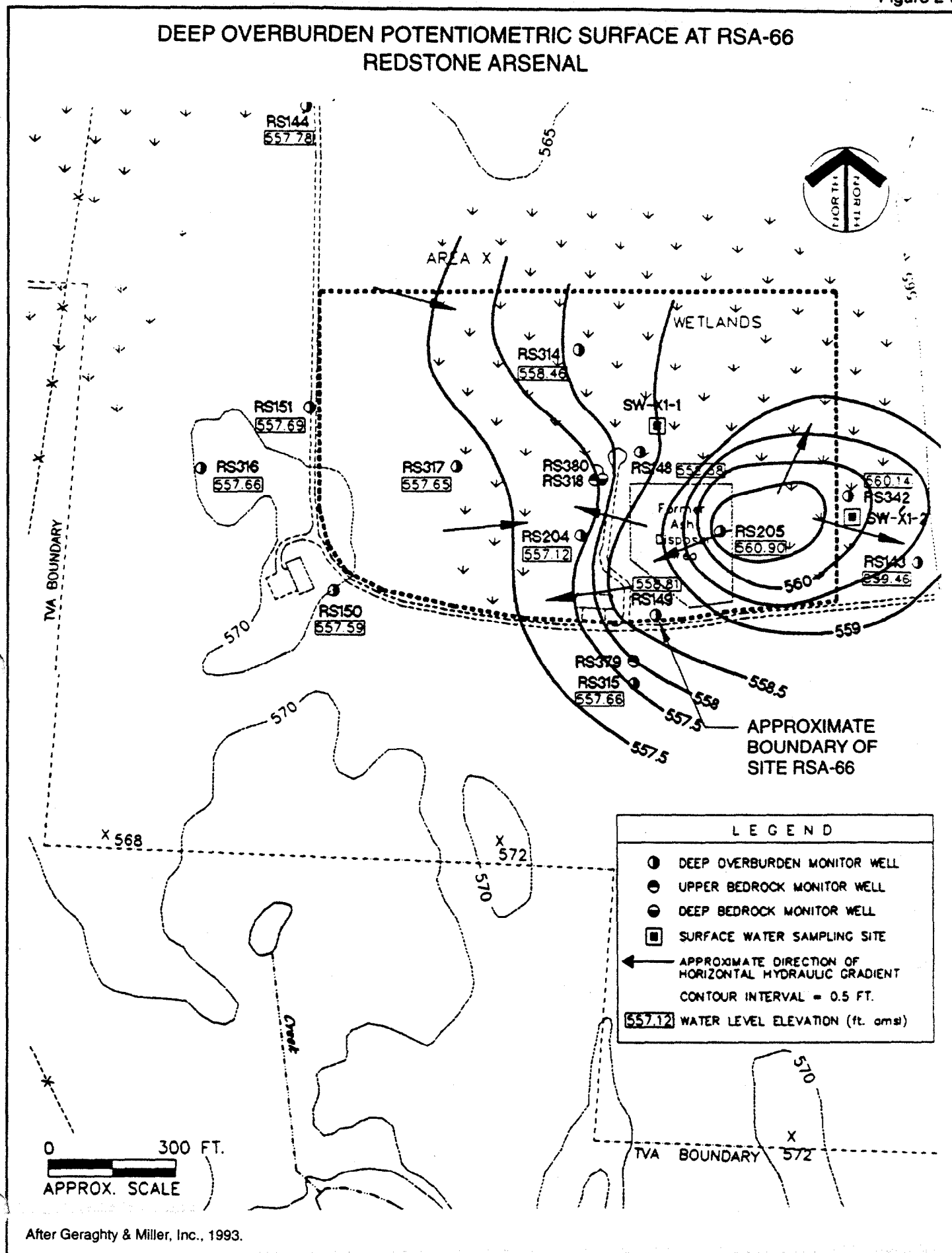


HYDROGEOLOGIC PROFILE ACROSS RSA-68 REDSTONE ARSENAL

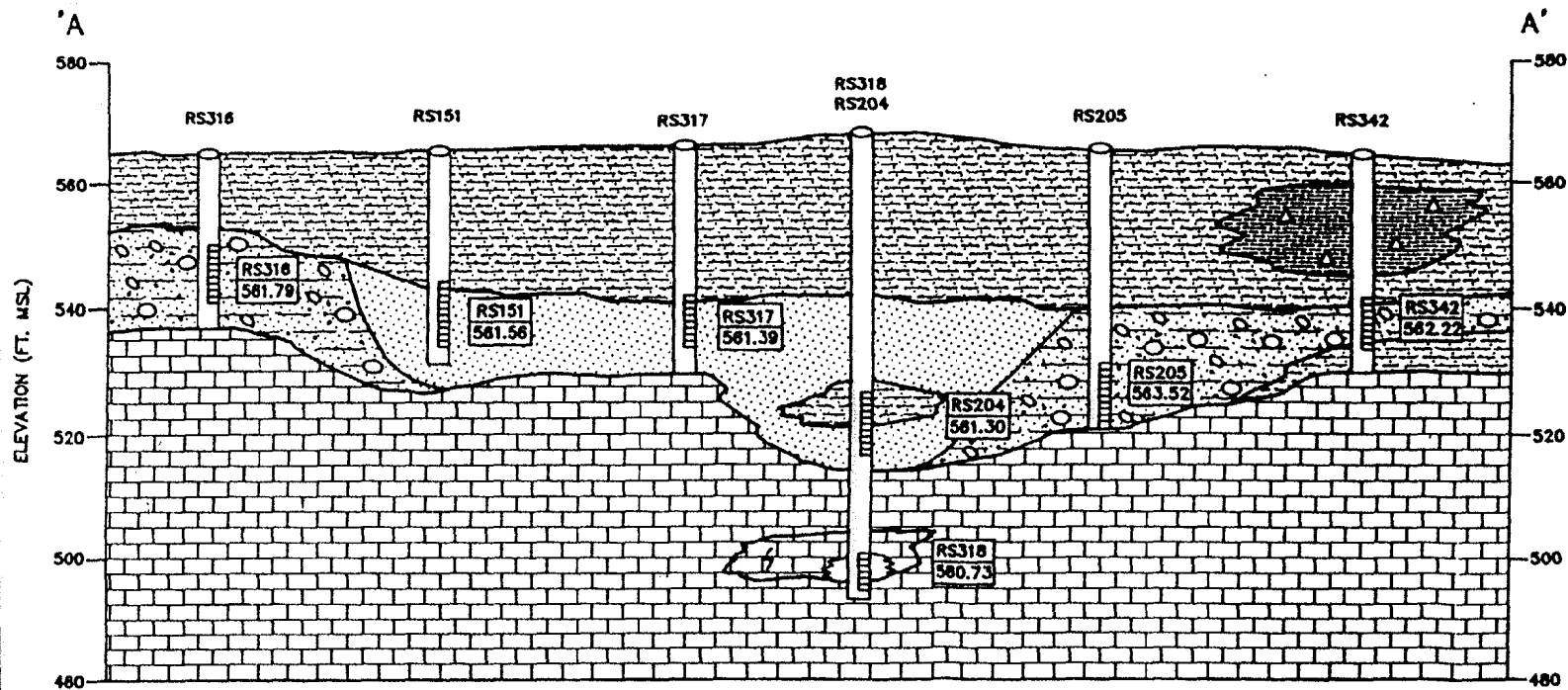


After Geraghty & Miller, Inc., 1993

Figure 2-5



HYDROGEOLOGIC PROFILE ACROSS RSA-66 REDSTONE ARSENAL



LEGEND

RS316
561.79



Composite Well
Bore, Number and
Water Level for
Screened Interval

Water Level Measurements
Obtained April 30, 1991



Sandy Clay



Poorly Sorted Sand



Silty and Clayey
Sand and Gravel



Dense Clay with
Chert Fragments



Limestone



Limestone with
Fracture Zones or
Solution Cavities

Vertical Exaggeration = 10X

Horizontal
Scale

0 200

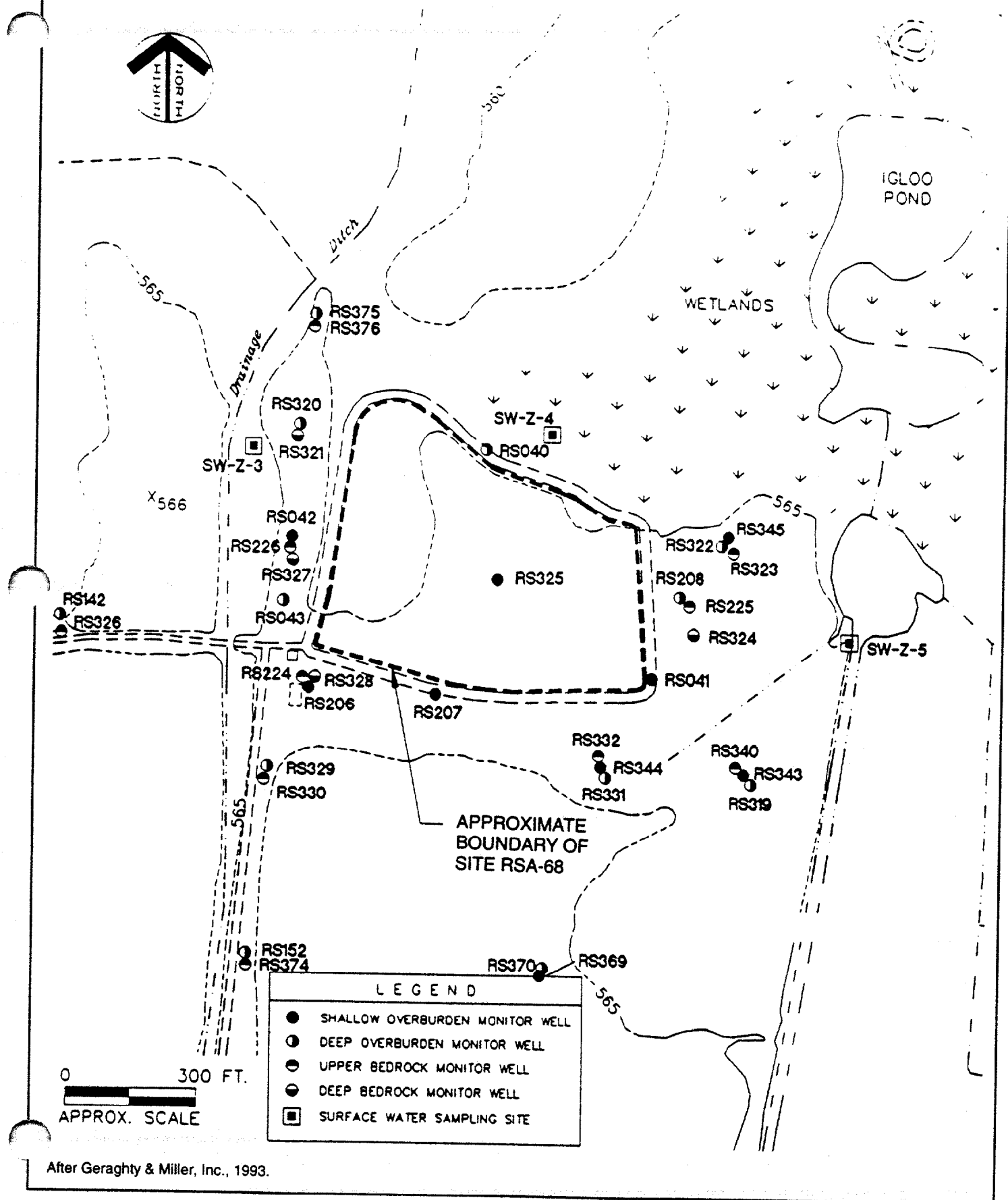
540

Vertical
Scale

520

After Geraghty & Miller, Inc., 1993

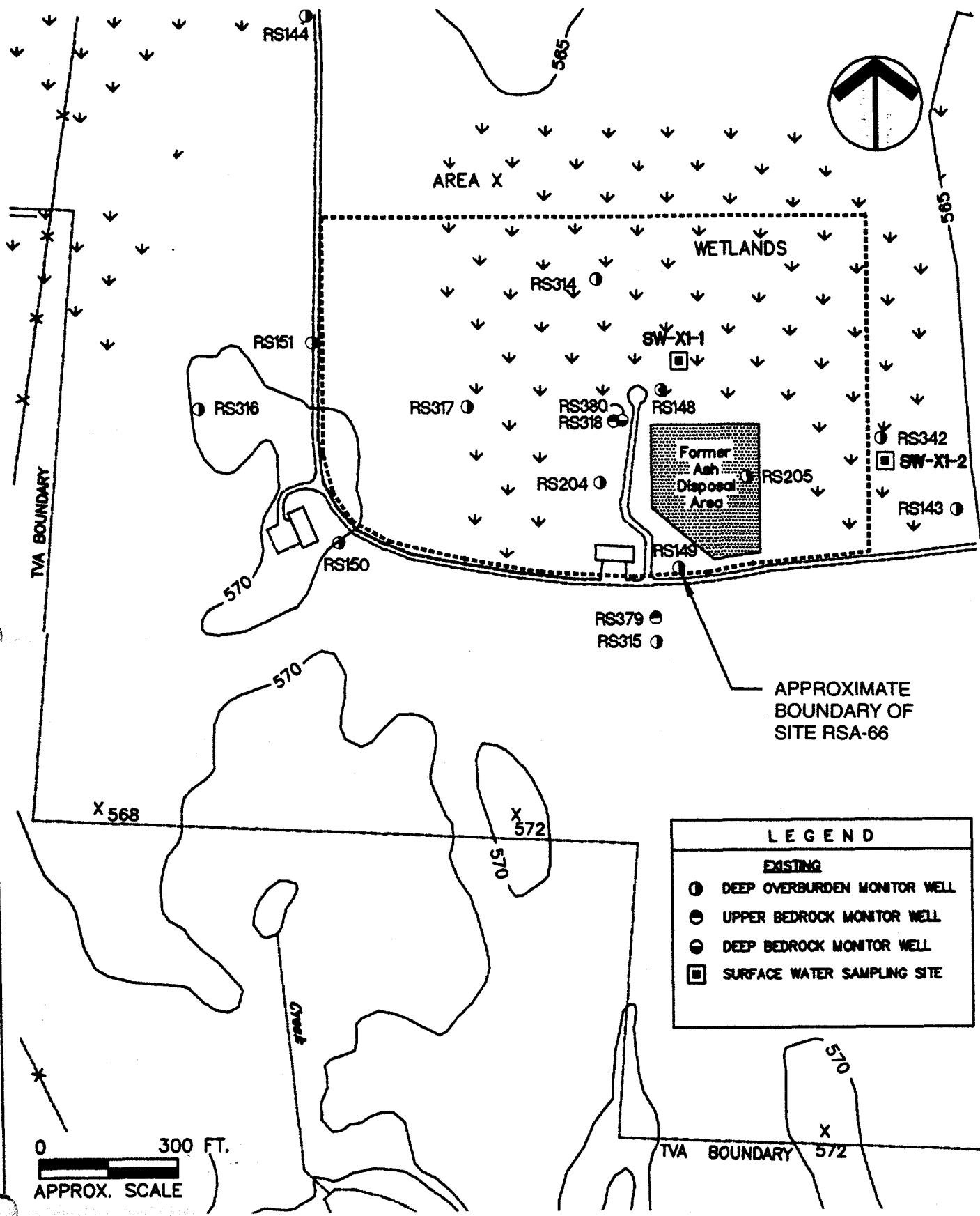
PLAN MAP OF SITE RSA-68 REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

Figure 2-2

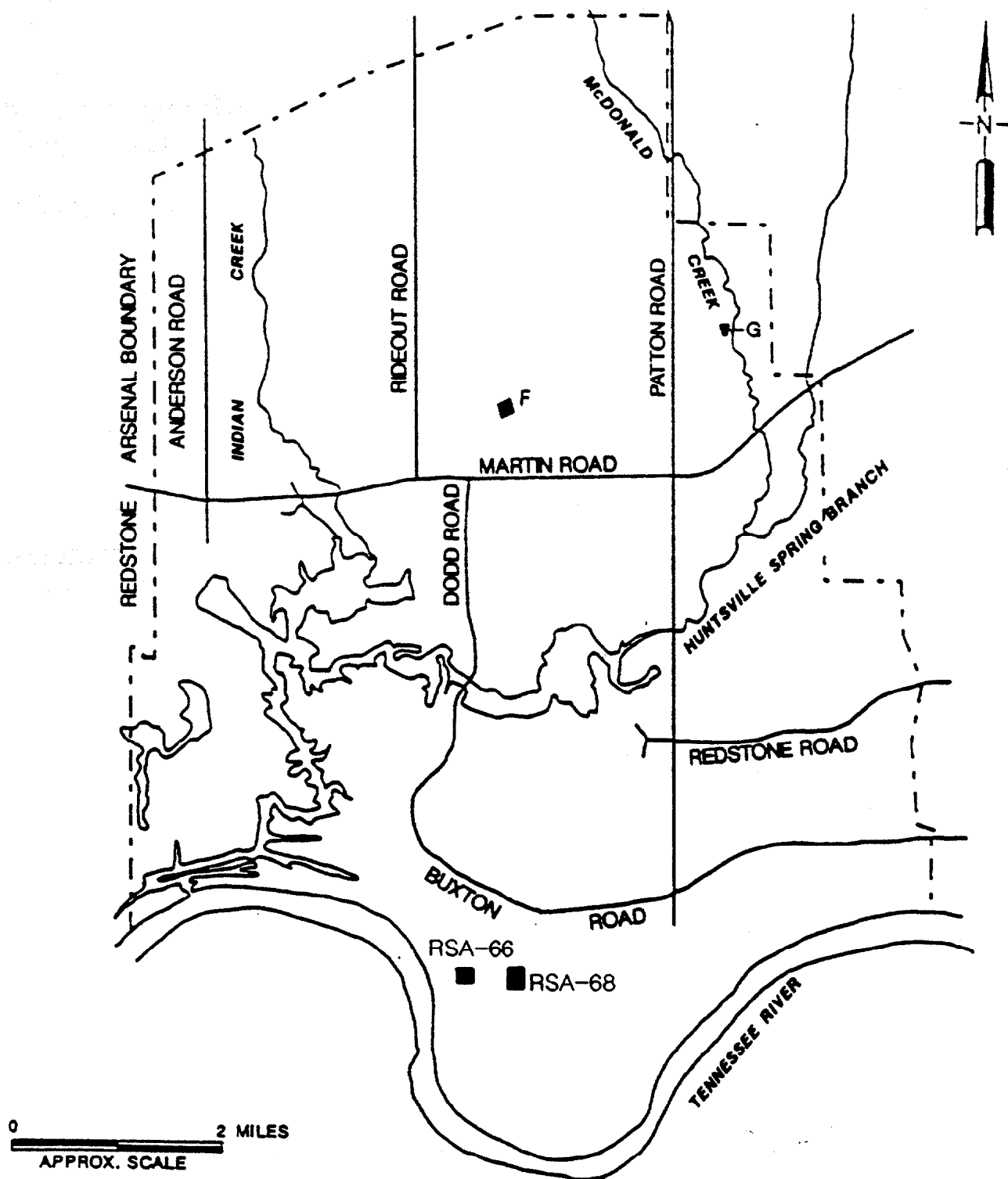
PLAN MAP OF SITE RSA-66 REDSTONE ARSENAL



LEGEND	
<u>EXISTING</u>	
○	DEEP OVERBURDEN MONITOR WELL
●	UPPER BEDROCK MONITOR WELL
⊙	DEEP BEDROCK MONITOR WELL
□	SURFACE WATER SAMPLING SITE

After Geraghty & Miller, Inc., 1993.

LOCATION OF SITES RSA-66 AND RSA-68 (GROUP X4B(u))
REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

SECTION 3

SCOPING OF THE RI/FS

3.0.a This section presents information used for developing the scope of activities to be conducted during the RI/FS, including potential remedial action technologies, preliminary identification of ARARs, data quality objectives, and data gaps and data needs.

3.1 CONCEPTUAL SITE MODEL

3.1.a The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors. The number of contaminant pathways are determined by the characteristics of the contaminants, complexity of the site and ecosystem, and potential for exposure to both human and ecological receptors. Site-specific CSMs for RSA-66 and RSA-68 are discussed in Section 4 and are presented in Figures 4-3 and 4-4 (human receptors) and Figures 4-5 and 4-6 (ecological receptors).

The media of concern identified at RSA-66 and RSA-68 are as follows:

- surface soil;
- subsurface soil;
- groundwater;
- surface water/sediment in the wetland area; and
- surface water/sediment in the drainage ditches.

3.2 SCOPING OF POTENTIAL REMEDIAL ACTION TECHNOLOGIES

3.2.a The following remedial alternatives were identified in the draft CMS Report (ESE, 1993) as being potentially applicable:

- **RSA-66**
 - Alternative 1 - Excavation/Offsite Landfill
 - Alternative 2 - No action

- **RSA-68**
 - Alternative 1 - Capping
 - Alternative 2 - No action

3.3 PRELIMINARY IDENTIFICATION OF ARARS

3.3.a Potential chemical specific ARARs or To Be Considered (TBC) criteria must be identified initially in order to establish data quality objectives (Section 3.4). Quantitation limits for the analytical methods used during the RI should not exceed the ARAR values for given contaminants.

3.3.b Applicable requirements are defined as those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Relevant and appropriate requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations reasonably similar to those encountered at the site. Potential sources for ARARs for RSA are described below. TBC criteria include state or federal screening criteria that may be used to evaluate contaminants when ARARs are not available.

3.3.1 Groundwater ARARs

3.3.1.a Potential ARARs for groundwater, listed on Table 3-1 of the General Work Plan (Parsons ES, 1996), include Safe Drinking Water MCLs and Alabama Maximum Contaminant Levels and Secondary Drinking Water Standards. Potential TBC criteria include EPA Region III Risk-Based Concentrations (RBC) for tap water issued for the protection of human health.

3.3.2 Surface Water ARARs

3.3.2.a Potential ARARs for surface water, listed on Table 3-2 of the General Work Plan (Parsons ES, 1996), include Federal and Alabama water quality criteria for freshwater organisms and Federal water quality criteria for human health with respect to ingestion of organisms. Potential TBC criteria include EPA Region IV freshwater surface water screening values for freshwater organisms.

3.3.3 Soil and Sediment ARARs

3.3.3.a ARARs are not available for soil or sediment. TBC criteria for sediment include EPA Region IV sediment screening values for EPA Ecotox thresholds and ecological receptors (Table 3-3 of the General Work Plan). EPA Region III RBCs may

be used as TBC criteria for soil and sediment for the evaluation of potential impacts to human health from these media (Table 3-4 of the General Work Plan).

3.4 DATA QUALITY OBJECTIVES

3.4.a Data quality objectives (DQOs) are qualitative statements that define the acceptability of data generated by an investigation. The DQO process and data categories are described in Section 3 of the General Work Plan.

3.4.1 Intended Uses of Data

3.4.1.a The data generated by the investigations at the Group X4B(u) Sites must be of sufficient quality to complete the RI and FS efforts.

3.4.2 Data Quality

3.4.2.a Both screening and definitive data will be required to meet the data quality necessary to support the RI and FS efforts. The screening data will be generated by the following field analyses.

- **Groundwater** screening will be conducted for pH, conductivity, temperature, and turbidity to ensure that the samples are representative of the formation water and to determine general water quality for evaluation of treatment in FS. Testing for pH, conductivity, and temperature will be conducted using direct reading probes. Testing for turbidity will be conducted using a turbidity meter.
- **Surface water** screening will be conducted for pH and hardness to establish existing water quality characteristics. Since availability of metals for uptake by plants and animals is related in part to pH and hardness, these measurement are also required for the Ecological Risk Assessment. Hardness will be measured using a Hach® test kit and pH will be measured with a direct reading probe.
- **Sediment** analyses for pH will be conducted to determine basic chemical characteristics of the sediment. Measurement of pH is also required for the Ecological Risk Assessment, since availability of metals in sediments is pH-dependent. Measurements of pH will be made with a direct reading probe or with pH paper.

3.4.2.b The definitive data, to be used for the BRA, will be generated by the following laboratory analyses:

- **Groundwater** definitive chemical analyses for target compound lists (TCL) volatile organic compounds (VOCs) by USEPA CLP SOW for Organic Analyses OLM03.1, target analyte list (TAL) metals by USEPA CLP SOW for Inorganic Analyses ILM3.0, and explosives by USEPA Test Methods for

Evaluating Solid Waste, Physical/Chemical Methods (SW846) SW8330 Method.

- **Surface water** definitive chemical analyses for TCL VOCs, TCL semivolatile organic compounds (SVOCs) and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1, TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0 and explosives by SW846 SW8330 Method.
- **Sediment** definitive chemical analyses for TCL VOCs, TCL SVOCs and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1, TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0, explosives by SW846 SW8330 Method, and total organic carbon (TOC) by SW846 SW9060 Method.
- **Sediment Bioaccumulation Testing.** A whole sediment bioaccumulation study using *Lumbriculus variegatus* (Oligochaeta) will be conducted. For bioaccumulation studies, *L. variegatus* are frequently a preferred type of organism because they remain in contact with the sediment serving as a source, are readily cultured in the laboratory, and tolerate varying physico-chemical characteristics of sediments. For testing sediments from the RSA-66 and RSA-68-associated stations, a 28-day exposure to whole sediment from each station is proposed in accordance with USEPA Test Method 100.3 in *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates*, EPA 600/R-94/024 (1994). Five replicate assays will be performed for each sediment sample. A clean negative control will also be included. Following a 24-hr washout period to allow the *L. variegatus* to clear their guts, analytical chemistry and lipid analysis will be performed. The *L. variegatus* from the five replicates for each sediment sample will be combined as a composite sample for chemical analysis. Chemical analyses will be in accordance with the relevant USEPA protocols for the contaminants of interest, and the USEPA recommended Bligh-Dyer method will be used for lipid analysis. Comparison of the results with the corresponding chemical concentrations in the sediment samples will allow estimation of bioaccumulation in the *L. variegatus* tissue.

A summary of the accuracy and precision DQOs for the definitive laboratory chemical data is presented in Table 3.5 of the General Work Plan.

SECTION 4

TASK PLAN FOR THE RI

4.0.a This section identifies the activities that will be conducted during the RI at Sites RSA-66 and RSA-68. Field activities will be conducted under Task Order 0008 of Contract No. DACA87-95-D-0018.

4.0.b A total of 51 groundwater samples, 8 surface water, and 8 sediment samples will be collected from Group X4B(u) for chemical analysis. Analyses for all of the media to be sampled are summarized in Section 3, Data Quality Objectives.

4.1 PRE-FIELD ACTIVITIES

4.1.a Prior to commencement of field activities, the Group X4B(u) sampling locations will be cleared for UXOs.

4.2 FIELD INVESTIGATIONS

4.2.a Field activities planned for this investigation include:

- Surface water and sediment investigation;
- Groundwater investigation;
- Ecological investigation; and
- Surveying.

4.2.b All field procedures are provided in the Field Sampling Plan (Appendix B). Investigation-derived waste (IDW) generated during this field effort will be handled according to the procedures described in the IDW Plan (General RI/FS Work Plan (Parsons ES, 1996) Appendix E). All field activities will be performed in compliance with the site-specific Safety and Health Plan (Appendix A) and the Ordnance Management Plan (Appendix C, General RI/FS Work Plan, Parsons ES, 1996). Since it is possible that recovered chemical warfare material may be encountered during field activities at RSA-66 and RSA-68.

4.2.c Background data is currently being compiled for groundwater and soil at RSA by CESAS. If available, it will be incorporated in this study.

4.2.1 Surface Water and Sediment Investigation

4.2.1.a Eight surface water/sediment samples will be collected from the locations shown in Figures 4-1 and 4-2. Surface water and sediment sample locations will be co-located. The purpose of the surface water/sediment analyses is to provide information to support the RA and FS. The samples will be analyzed for the compounds discussed in Section 3.5, which include VOCs, SVOCs, metals, pesticides, pH, hardness and TOC. In addition, eight sediment bioassays will be conducted for RSA 66 and RSA 68.

4.2.1.b Four surface water and four sediment samples will be collected from RSA-66 at the locations shown in Figure 4-1. Two samples will be collected from the wetlands north of the site and two will be collected from in wetlands east of the site.

4.2.1.c Four surface water and four sediment samples will be collected from RSA-68 at the locations shown in Figures 4-1 and 4-2. Two samples will be collected from the wetlands northeast of the site and two will be collected from the drainage ditch west of the site.

4.2.1.d Whole sediment bioaccumulation studies (using *Lumbriculus variegatus*) will be conducted on the eight sediment samples collected (4 stations from RSA-66 and 4 stations from RSA-68). For testing sediments from the RSA-66 and RSA-68 stations, a 28-day exposure to whole sediment from each station is proposed in accordance with methods provided in Section 3.

4.2.2 Groundwater Investigation

4.2.2.a The groundwater investigation will include:

- Water level measurements; and
- Groundwater sampling and analysis.

4.2.2.1 Water Level Measurements

4.2.2.1.a Prior to beginning any other field work, water levels will be measured in 51 monitoring wells on and surrounding the sites. Table 4.1 identifies the monitoring wells for groundwater level monitoring. Procedures for water level measurement are provided in the Field Sampling Plan (Appendix B).

4.2.2.2 Groundwater Sampling

4.2.2.2.a Groundwater samples will be collected from 51 existing wells at the sites shown in Figures 4-1 and 4-2.

4.2.2.2.b Groundwater samples will shipped to the laboratory for analysis of VOCs, metals, hardness, and TOC. The samples will also be field-tested for pH, temperature, turbidity, and conductivity.

4.2.2.2.c Sampling methods are provided in the Field Sampling Plan (Appendix B).

4.2.3 Ecological Investigation

4.2.3.a The ecological characterization of RSA-66 and RSA-68 will be based on the methods described in the pre-approved Work Plan (USACE, 1994). This section describes the specific methods to be employed for the ecological characterization of RSA-66 and 68.

4.2.3.b Available information on the ecology of RSA-66 and RSA-68 will first be obtained and reviewed as described in the General RI/FS Work Plan (Parsons ES, 1996) and the pre-approved Work Plan (USACE, 1994). The most recent information on the actual or potential presence of state- and federally-listed threatened and endangered species, species of special concern, and wildlife and fisheries resources within the vicinity will be obtained. Information on unique and special-concern habitats, other preserves, and natural areas in the vicinity will also be obtained and reviewed.

4.2.3.c A field survey of the area within a 0.5-mile radius of RSA-66 and RSA-68 will be conducted in order to collect qualitative information on the types, extent, values and locations of biological resources. The field survey will include the follows elements:

- **Plant communities.** Plant communities will be identified as described in the General RI/FS Work Plan (Parsons ES, 1996).
- **Dominant plant species.** Dominant plant species will be identified qualitatively within each major terrestrial and wetland plant community. This will include the wetland system near RSA-66, and the wetland system associated with Upper and Lower Igloo Ponds near of RSA-68. Wetland areas will be surveyed on foot where accessible.
- **Terrestrial fauna.** Observations of terrestrial fauna will be made within the boundaries of RSA-66 and RSA-68, the adjacent wetland areas of both RSAs, and any upland areas. Mammals will be identified by tracks, scat, burrows, and actual sightings. Bird, reptile, and amphibian identifications will be made by actual sightings. All observations will be qualitative in nature.
- **Aquatic life.** Aquatic resources will be qualitatively evaluated from selected locations in the wetlands associated with RSA-66 and RSA-68, as site conditions allow. Small streams and drainage ditches within a 0.5-mile radius will be described and qualitatively addressed. Dominant species present will be identified qualitatively during the field survey by examining the habitats in the

area. Sediment bioaccumulation studies will be conducted for the 8 stations identified in Section 4.2.3. Methods to be used are described in Section 3. Physical location of the sampling stations may vary based on actual site conditions.

- **Vegetation stress.** Upland and wetland vegetation within the boundaries of RSA-66 and RSA-68 and within the 0.5-mile radius area will be examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage.

4.2.3.d A map will be prepared that illustrates the major upland and wetland plant communities of RSA-66 and RSA-68. Aquatic habitats and sampling locations will also be indicated on the map, as well as habitat or actual occurrence of any state- or federally-listed species, or federal species of special concern.

4.2.3.e A description of the ecological features of RSA-66 and RSA-68 will be prepared based on the updated literature review and field survey. This will provide the basis for selection of representative receptors, refinement of exposure scenarios for the risk assessment, and identification of protected species or valuable habitats in the vicinity.

4.2.4 Surveying

4.2.4.a Coordinates and elevations shall be established according to methods described in Appendix B for each monitoring well, soil boring, and surface water/sediment sampling site. The location, identification, coordinates, and elevations of the wells, borings, and surface water/sediment sampling sites shall be plotted on planimetric maps to show their location with reference to surface features within the project area.

4.3 DATA REDUCTION, VALIDATION, AND DOCUMENTATION

4.3.a Data generated during the Group X4B(u) Site investigations will be managed to document findings and to support the DQOs presented in Section 3. Qualitative data will be assembled and where possible, copied, for the project files. Quantitative data will be assembled both in hard-copy and electronic format for subsequent comparisons, evaluation and reporting. Quantitative data will become part of the site file also. The data reporting requirements of ERDMIS and USEPA's interchange file format (IFF) format shall be part of the data management process.

4.3.b The descriptions of the data reduction, validation and documentation processes for the RSA projects may be found in Section 4 of the General RI/FS Work Plan (Parsons ES, 1996), and in the pre-approved Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4 BASELINE RISK ASSESSMENT

4.4.a A baseline risk assessment, composed of a human health risk assessment (HHRA) and an ecological risk assessment (ERA), is performed to provide an estimate of current and future human health risk and ecological risk associated with hazardous substance releases at potentially contaminated sites. The results of the HHRA and the ERA will contribute to the overall characterization of RSA-66 and RSA-68 and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives.

4.4.b A risk-based screening of the data will be performed to identify chemicals of potential concern (COPCs) for both human health and ecological endpoints. The screening process and the methodology for performing the HHRA and ERA are briefly described below. The screening process and methodology are detailed in Section 4 of the General RI/FS Work Plan (Parsons ES, 1996) and in Section 2 of the pre-approved Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4.1 Identification of Chemicals of Potential Concern

4.4.1.a Prior to initiation of a baseline HHRA, a list of chemicals present in site samples (CPSS) and COPCs will be compiled. All chemicals detected in site media at RSA-66 and RSA-68 are considered CPSSs. From the list of CPSSs, COPCs are selected using the pre-approved Work Plan screening methodology. The details of the screening methodology are presented in Section 2.2 of the pre-approved Work Plan (USACE, 1994).

4.4.1.b Chemicals not eliminated using the screening process will be considered COPCs and will be quantitatively evaluated in the HHRA and/or ecological evaluation.

4.4.2 Human Health Risk Assessment

4.4.2.a Following identification of COPCs for the HHRA, the following major steps will be completed as detailed in Section 4 of the General RI/FS Work Plan and Section of the pre-approved Work Plan (USACE, 1994).

- Data evaluation
- Exposure assessment
- Toxicity assessment
- Risk characterization

4.4.2.b Components of these steps are discussed in this section where specific information is warranted. Otherwise, the General RI/FS Work Plan (Parsons ES, 1996)

and the pre-approved Work Plan (USACE, 1994) provide detailed methods and background material.

4.4.2.c RSA-66 and RSA-68 will be evaluated using site-specific exposure scenarios. Evaluation of past site activities and comparison of on-site and downgradient sample analytical data to background analytical data will be considered to determine which chemicals detected are likely to be site-related. Human health conceptual site models (CSMs) for RSA-66 and RSA 68 are presented in Figures 4-3 and 4-4, respectively. The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors.

4.4.2.1 Data Evaluation

4.4.2.1.a COPCs will be identified as discussed in Section 4.4.1.1. Environmental media to be considered in the HHRA include shallow soil (0-1 ft), subsurface soil (0-6 ft), surface water, sediment, and groundwater. Validated data from the most recent sampling efforts will be used, along with appropriate historical data, to quantify potential human health risks. Water media will be expressed in units of mg/L (ppm) and solid media (soil, sediment) in units of mg/kg (ppm).

4.4.2.2 Exposure Assessment

4.4.2.2.a The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at or migrating from a site. A completed pathway is comprised of the following four elements:

- A source and mechanism for chemical release;
- An environmental transport medium;
- An exposure point; and
- A human or ecological receptor and a feasible route of exposure at the exposure point.

4.4.2.2.b A pathway is not considered complete unless each of these elements is present.

4.4.2.2.c Consistent with Risk Assessment Guidance for Superfund (RAGS)(EPA, 1989a) and EPA Region IV policy (EPA, 1995a), current and reasonably foreseeable future land-use scenarios will be considered for RSA-66 and RSA-68. The sites are located in an area used by industrial workers; therefore, exposure of these workers will be assessed. The area is located in a restricted area; therefore, trespassing onto the site by nearby residents is not anticipated. In the future, land use will remain industrial; therefore, potential future receptors include industrial workers and recreational

trespassers. The Master Plan for RSA indicates that RSA-66 and RSA-68 are located in area that will be used for Operational Maintenance Facilities (US Army, 1996). Per EPA's "Land Use in the CERCLA Remedy Selection Process" (OSWER Directive No. 9355.7.04, 1995c), residential exposure is only considered appropriate when the current land use at the site is residential, or when there is a strong probability that residential development will occur at the site in the future. Given that neither of these criteria apply to RSA-66 and RSA-68, residential development is not a likely future land use.

Receptor Definitions

4.4.2.2.d The potential receptors are defined as follows for RSA-66 and RSA-68:

4.4.2.2.e **Current and Future Workers:** Workers are defined as individuals that are employed at or near the site, and who have unlimited access to site media. Current and future workers are assumed to be exposed to surface soil (0 to 1 foot in depth). However, future workers are considered exposed to mixed soil, given natural erosion effects and potential excavation. Incidental ingestion of soil, dermal contact with soil, inhalation of fugitive dust from soil, and inhalation of volatiles from soil are potential pathways for exposure to soil. Future workers are also assumed to be exposed to groundwater (drinking water) via ingestion and dermal contact. Inhalation of volatiles while showering/bathing will not be considered for these receptors assuming showering activities will occur at home rather than at the site.

4.4.2.2.f Although surface water and sediment are located on the site (wetland area and drainage ditches), the nature of the jobs performed by the workers at these sites are not likely to result in significant contact with these media.

4.4.2.2.g Details concerning the methodology to be used for determining exposure estimates (RME and CT), exposure point concentrations, and the toxicity assessment are provided in Section 2 of the pre-approved Work Plan (USACE, 1994).

4.4.2.2.h Current and future risks for each receptor at each site will be calculated and depicted in the Risk Characterization Section of the BRA, in accordance with the General RI/FS Work Plan (Parsons ES, 1996) and the pre-approved Work Plan (USACE, 1994). An uncertainty assessment will also be completed as outlined in the General RI/FS Work Plan (Parsons ES, 1996) and the pre-approved Work Plan (USACE, 1994). Remediation goals will be calculated in accordance with EPA Region IV guidance as described in Sections 2.5.1.1 and 2.5.2.1 of the pre-approved Work Plan (USACE, 1994).

4.4.3 Ecological Risk Assessment

4.4.3.a Methods used to conduct the ecological risk assessment are outlined in Section 2 of the pre-approved Work Plan (USACE, 1994). The purpose for collecting

additional data is to supplement pre-existing data from previous investigations and fill data gaps identified. Previous data will be evaluated for use in the risk assessment. The data to be collected as described in this risk assessment will be quantitatively evaluated.

4.4.3.1 Problem Formulation

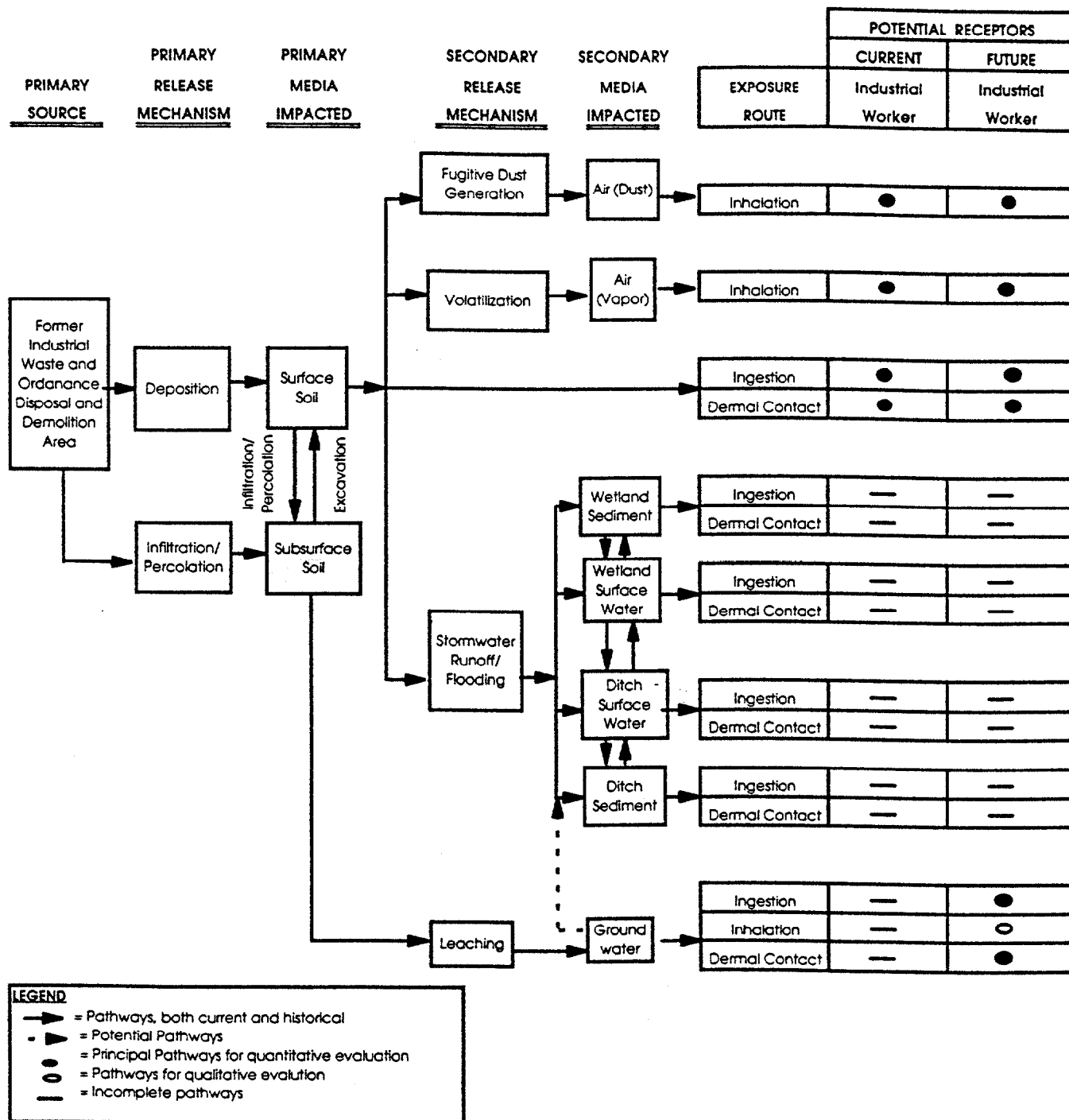
4.4.3.1.a The protection of ecological resources, such as habitats and species of non-domesticated plants and animals, is a principal motivation for conducting the ERA. Ecological endpoints will be identified in the text of the ERA to assess whether significant adverse ecological effects have occurred or may occur at RSA-66 and RSA-68 as a result of ecological receptors' exposure to COPCs. COPCs will be selected for use in the ERA in accordance with the methodology as described in the pre-approved Work Plan (USACE, 1994).

4.4.3.1.b The ecological characterization will be performed as described in Section 4.2.5 Ecological Investigation. The result of the ecological characterization will be to provide the risk assessors with information to select representative receptors, refine exposure scenarios for the ERA, and provide information on protected species. Ecological endpoints will be defined in the ERA in accordance with the guidance set forth in the pre-approved Work Plan (USACE, 1994). Given the habitat diversity at RSA-66 and RSA-68, ecological endpoints will consider sensitive habitats and species associated with the wetland areas and surface waters on and adjacent to the sites.

4.4.3.1.c Receptors will be selected based on the results of the site characterization and other selection factors as identified in Section 4.4.3 of the General RI/FS Work Plan (Parsons ES, 1996). The terrestrial receptors identified in previous ERA for RSA-66 and RSA-68 and considered for this ERA include: the mouse (*Peromyscus* sp.), white-tailed deer (*Odocoileus virginianus*), common bobwhite quail (*Colinus virginianus*), gray bat (*Myotis grisescens*), and bald eagle (*Haliaeetus leucocephalus*). Potential aquatic receptors include: fathead minnow (*Pimephales promelas*), largemouth bass (*Micropterus salmoides*), green frog (*Rana clamitans*), caddisfly (*Cheumatopsyche* sp. and *Hydropsyche* sp.), and chironomid (*Chironomus* sp.). Habitat conditions will be verified to determine whether site conditions would support endangered species. Receptors selected will be identified and described in the ERA.

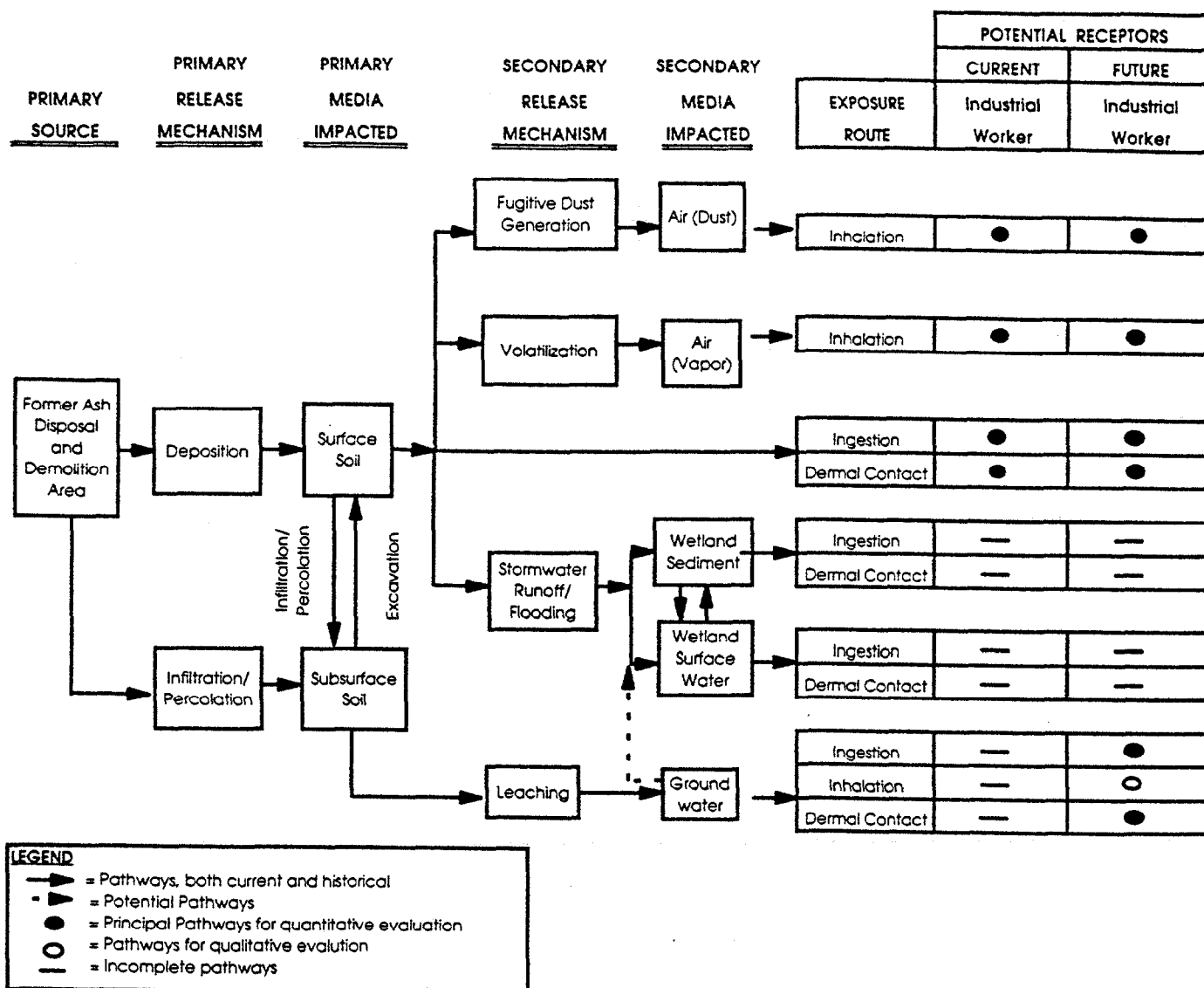
4.4.3.1.d Conceptual site models are presented in Figures 4-5 and 4-6 for RSA-66 and RSA-68, respectively. These CSMs are based on previous investigation results, a brief site visit, and evaluation of the site investigation results. Professional judgment will be used to select the most appropriate risk hypotheses and document the rationale for selection of endpoints.

HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RSA-68: FORMER INDUSTRIAL WASTE AND ORDNANCE DISPOSAL AND DEMOLITION AREA REDSTONE ARSENAL



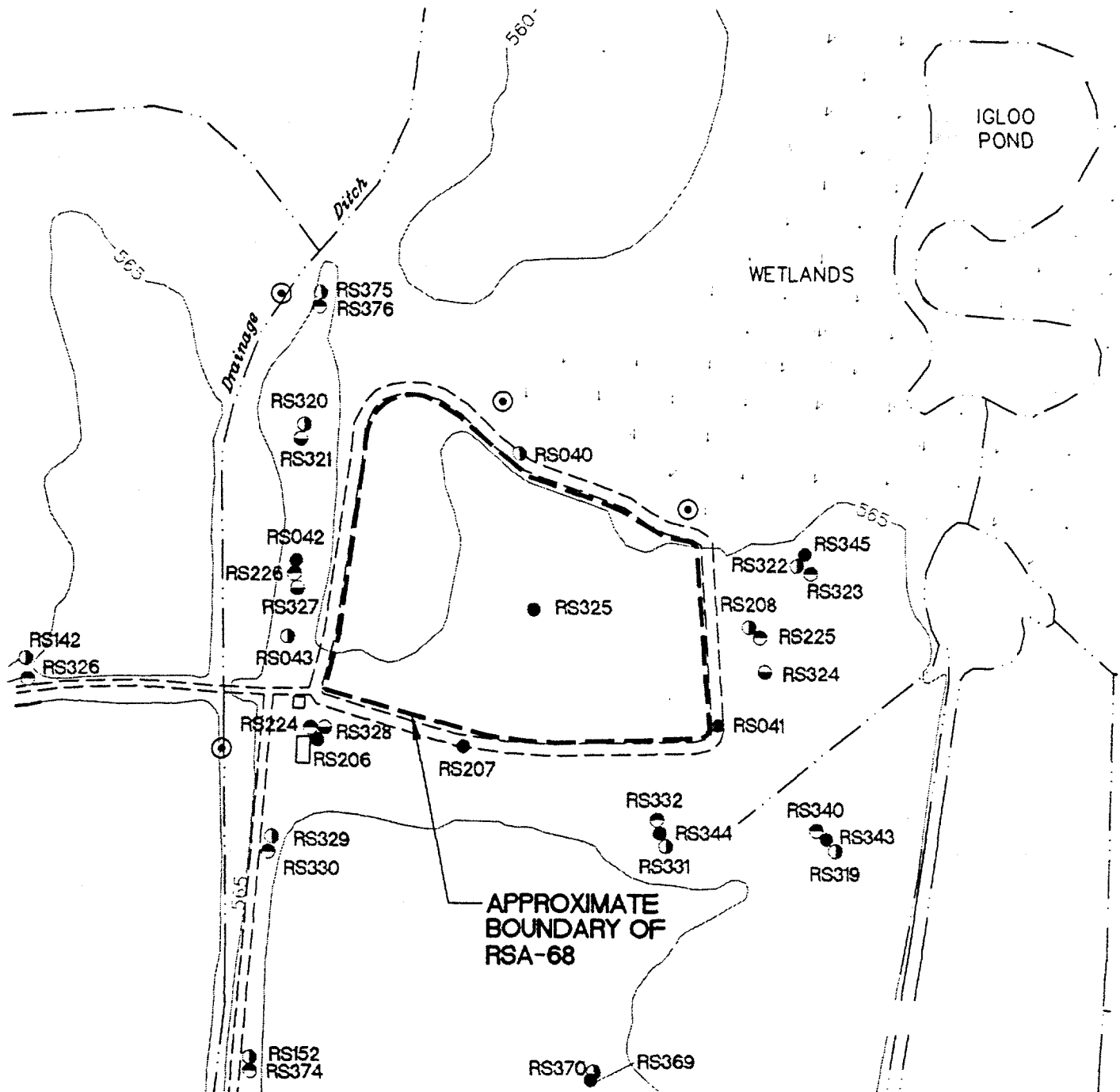
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HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RSA-66: FORMER ASH DISPOSAL AND DEMOLITION AREA REDSTONE ARSENAL



PROPOSED SAMPLE LOCATION MAP

RSA-68
REDSTONE ARSENAL



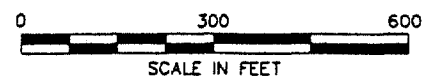
LEGEND

- ⊙ PROPOSED SURFACE WATER/SEDIMENT/BIOASSAY SAMPLE
- SHALLOW OVERBURDEN MONITOR WELL
- ⊖ DEEP OVERBURDEN MONITOR WELL
- ⊕ UPPER BEDROCK MONITOR WELL
- ⊗ DEEP BEDROCK MONITOR WELL

AFTER GERAGHTY & MILLER, 1993.
FIGURE 4-2: RSA-68-P, 09-12-96 at 10:00

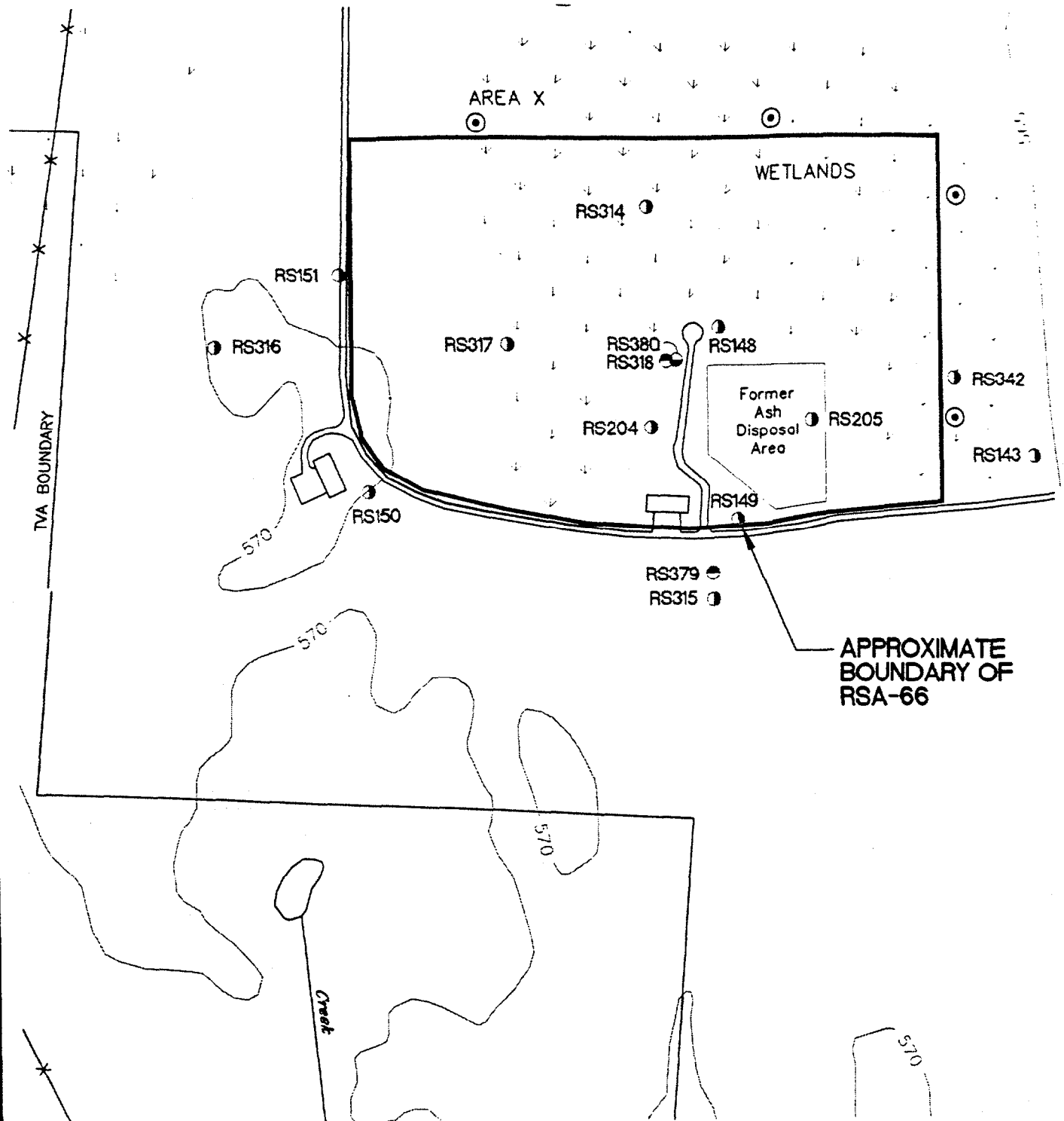


PARSONS ENGINEERING SCIENCE, INC.



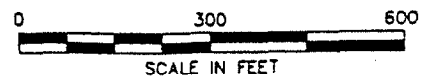
PROPOSED SAMPLE LOCATION MAP

RSA-66
REDSTONE ARSENAL



LEGEND

- PROPOSED SURFACE WATER/SEDIMENT/BIOASSAY SAMPLE
- SHALLOW OVERBURDEN MONITOR WELL
- DEEP OVERBURDEN MONITOR WELL
- UPPER BEDROCK MONITOR WELL
- DEEP BEDROCK MONITOR WELL



AFTER GERAGHTY & MILLER, 1993.
P. 129363 (CADD) RSA-66-P. 09/18/96 J. 09/97



PARSONS ENGINEERING SCIENCE, INC.

4.4.3.2 Exposure Characterization

4.4.3.2.a Potential exposure pathways are depicted in the CSMs, Figures 4-5 and 4-6. Soil, sediment, and surface water pathways will be evaluated. The exposure profile will be detailed in the ERA to include a discussion of endpoint selection. Empirical and site specific data will be used to determine endpoints. Toxicity reference values will be developed in accordance with methods provided in the pre-approved Work Plan (USACE, 1994).

4.4.3.2.b Site-specific bioconcentration factors will be derived where appropriate based on results of bioaccumulation studies. Whole sediment bioaccumulation studies using *Lumbriculus variegatus* (Oligochaeta) will be conducted. Sediment samples will be collected as described in Section 4.3. *L. variegatus* is frequently a preferred type of organism because it remains in contact with the sediment serving as a source, is readily cultured in the laboratory, and tolerates varying physico-chemical characteristics of sediments. For testing sediments from RSA-66 and RSA-68 associated stations, a 28-day exposure to whole sediment from each of 8 samples is proposed in accordance with EPA methods outlined in Section 3.

4.4.3.3 Risk Characterization

4.4.3.3.a The risk characterization section of the ERA will describe the likelihood, severity, and characteristics of adverse effects to environmental stressors present at RSA-66 and RSA-68. Hazard quotients will be developed as described in the pre-approved Work Plan (USACE, 1994).

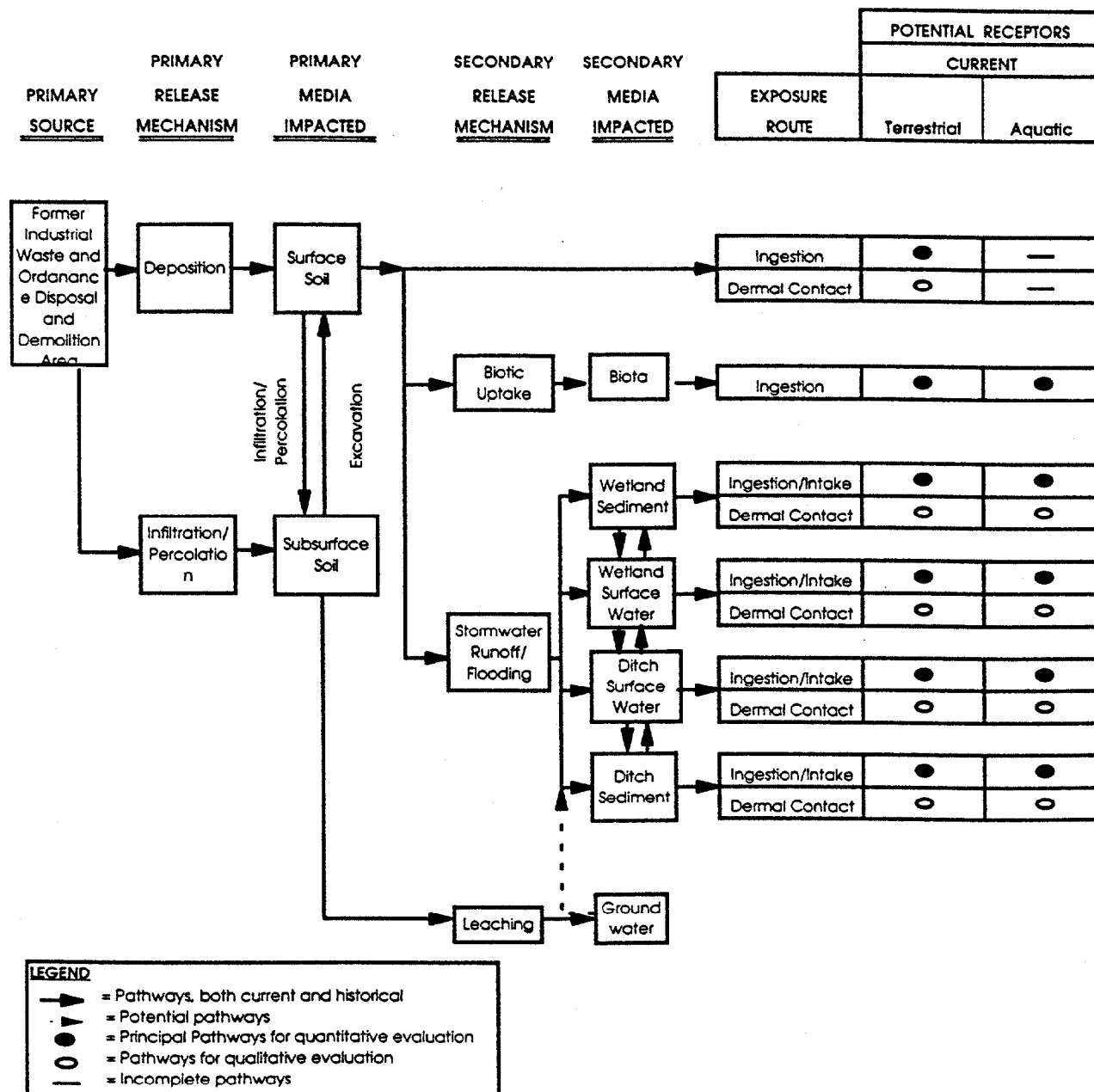
4.4.3.4 Analysis of Risk Uncertainty

4.4.3.4.a A qualitative analysis will be made of the uncertainties associated with the ERA. The components of the uncertainty analysis are described in the pre-approved Work Plan (USACE, 1994).

4.5 DATA REPORTING

4.5.a Upon completion of all field and analytical work specified in the SAP, Parsons ES will submit a QC Summary Report. The report will summarize the QC activities, non-conformance reports Parsons ES's review of field and laboratory data. A description of the contents of the report may be found in Section 4.5 of the General Work Plan (Parsons ES, 1996).

ECOLOGICAL CONCEPTUAL SITE MODEL FOR RSA-68: FORMER INDUSTRIAL WASTE AND ORDNANCE DISPOSAL AND DEMOLITION AREA REDSTONE ARSENAL



ECOLOGICAL CONCEPTUAL SITE MODEL FOR RSA-66: FORMER ASH DISPOSAL AND DEMOLITION AREA REDSTONE ARSENAL

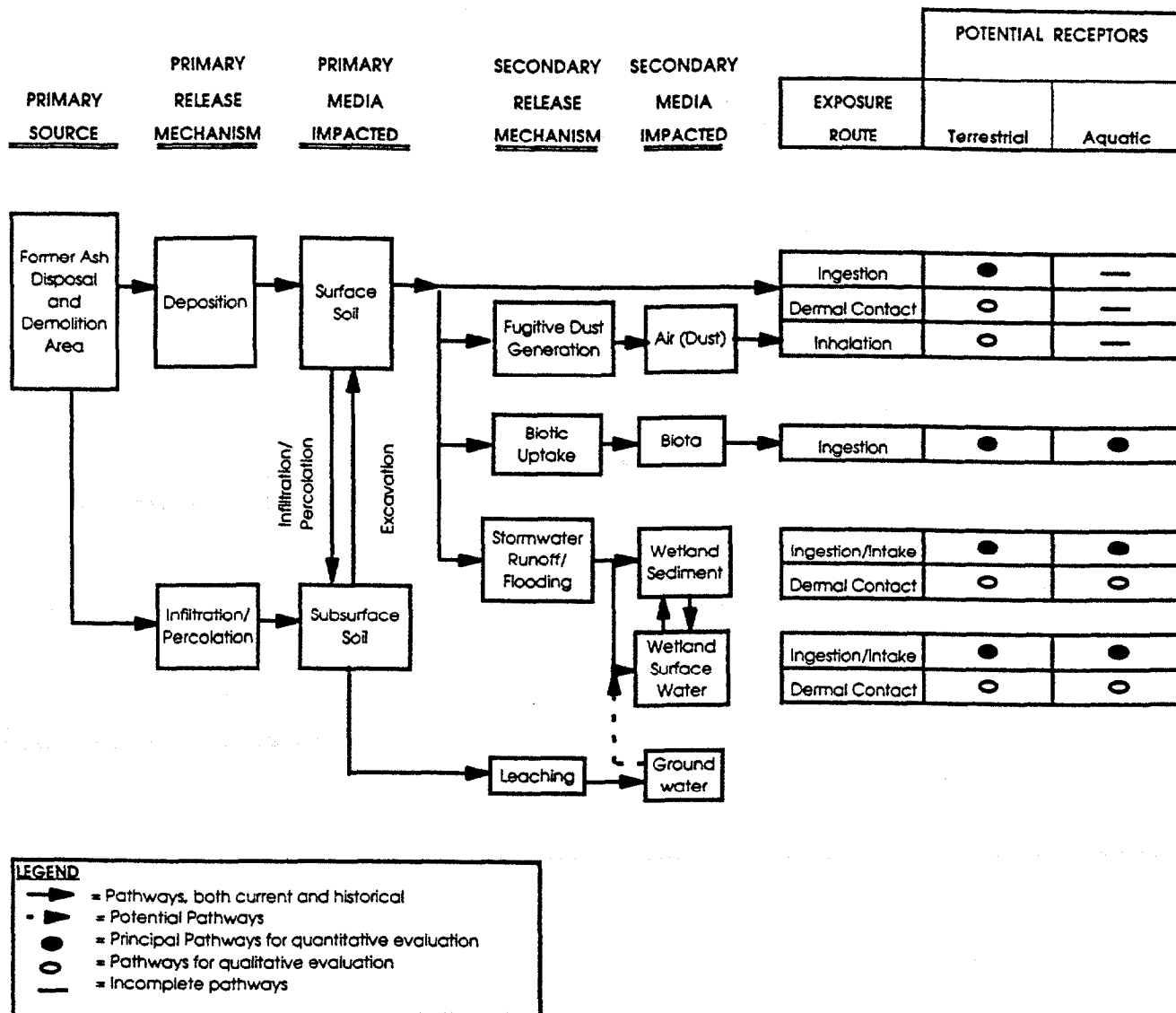


Table 4.1 Group X4B(u)
Existing Monitoring Wells for Groundwater Sampling

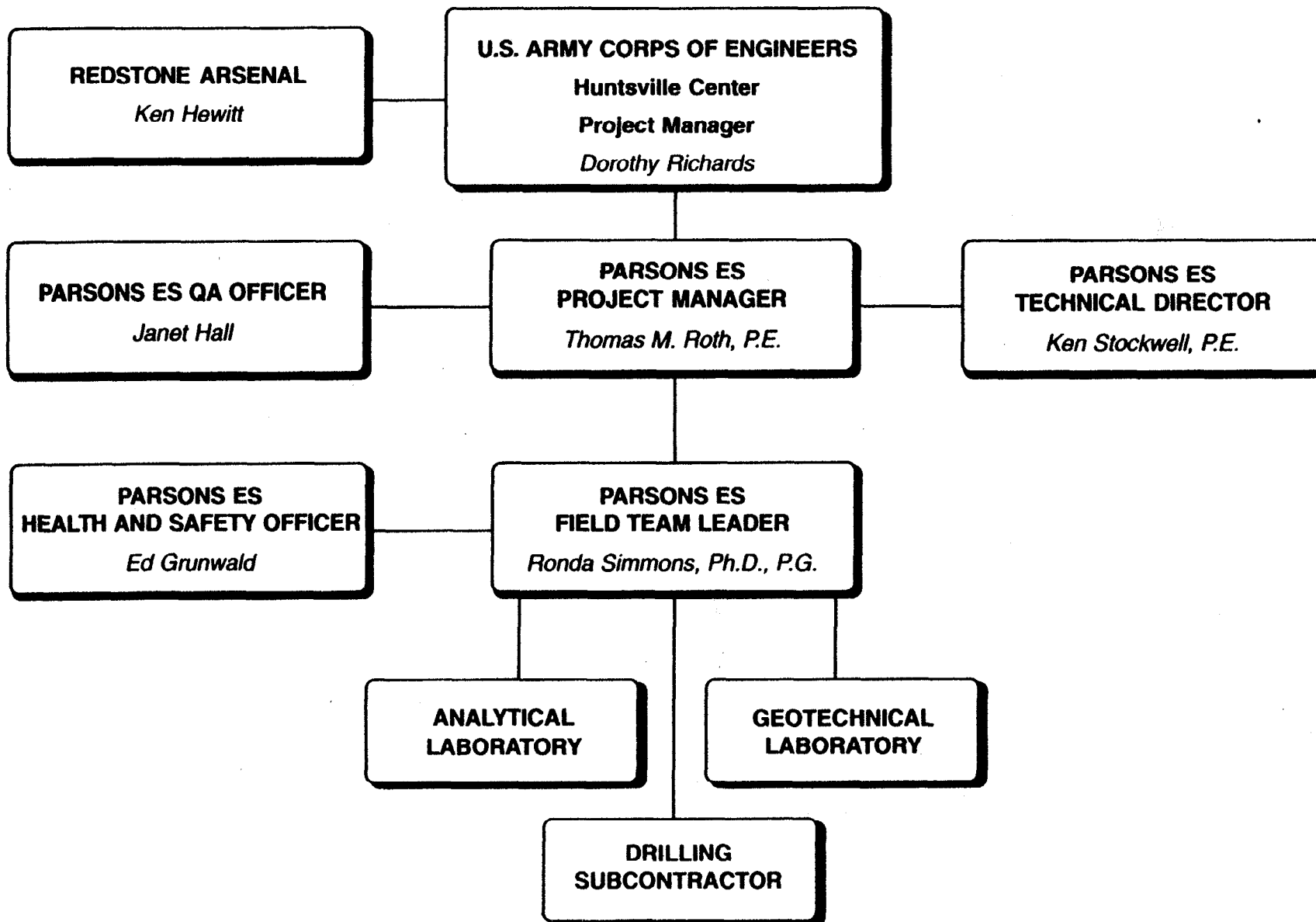
RSA-66		RSA-68	
Well Name	Aquifer	Well Name	Aquifer
RS143	Deep Overburden	RS040	Deep Overburden
RS144	Deep Overburden	RS041	Shallow Overburden
RS148	Deep Overburden	RS042	Shallow Overburden
RS149	Deep Overburden	RS043	Deep Overburden
RS150	Deep Overburden	RS142	Deep Overburden
RS151	Deep Overburden	RS152	Deep Overburden
RS204	Deep Overburden	RS206	Shallow Overburden
RS205	Deep Overburden	RS207	Shallow Overburden
RS314	Deep Overburden	RS208	Deep Overburden
RS315	Deep Overburden	RS224	Upper Bedrock
RS316	Deep Overburden	RS225	Upper Bedrock
RS317	Deep Overburden	RS226	Upper Bedrock
RS318	Upper Bedrock	RS319	Deep Overburden
RS342	Deep Overburden	RS320	Deep Overburden
RS379	Upper Bedrock	RS321	Deep Bedrock
RS380	Deep Bedrock	RS322	Deep Overburden
		RS323	Upper Bedrock
		RS324	Deep Bedrock
		RS325	Shallow Overburden
		RS326	Upper Bedrock
		RS327	Deep Bedrock
		RS328	Deep Bedrock
		RS329	Deep Overburden
		RS330	Upper Bedrock
		RS331	Deep Overburden
		RS332	Upper Bedrock
		RS340	Upper Bedrock
		RS343	Shallow Overburden
		RS344	Shallow Overburden
		RS345	Shallow Overburden
		RS369	Shallow Overburden
		RS370	Deep Overburden
		RS374	Upper Bedrock
		RS375	Deep Overburden
		RS376	Upper Bedrock

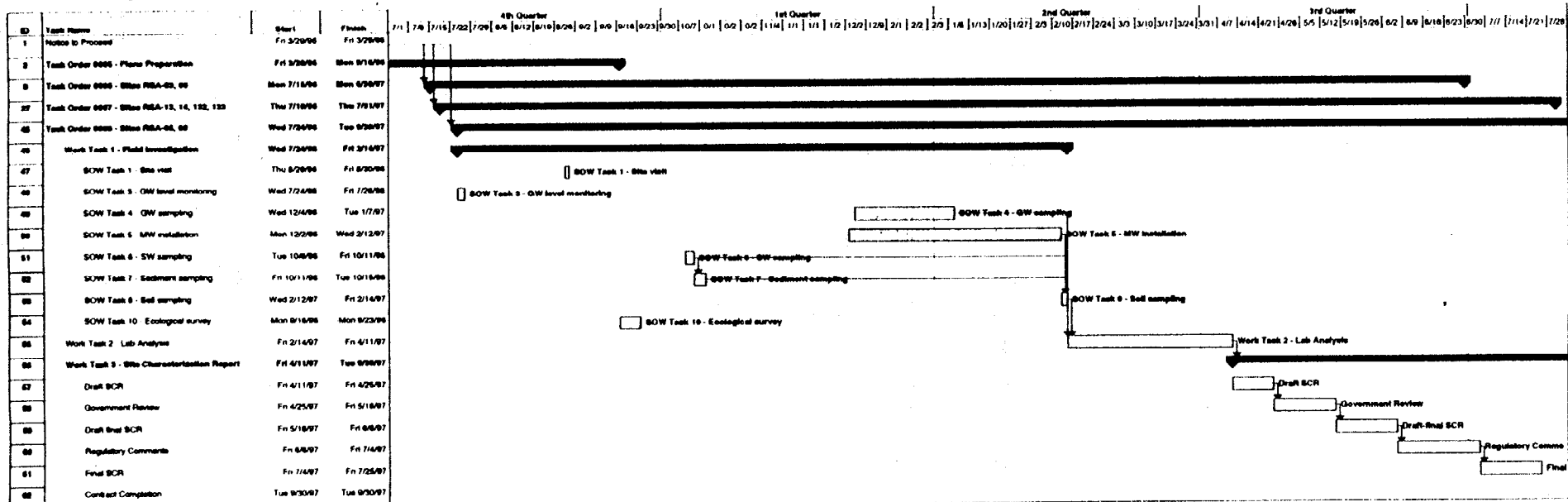
SECTION 5

TASK PLAN FOR THE FEASIBILITY STUDY

5.0.a The Feasibility Study (FS) will be performed according to the procedures outlined in the *Final Work Plan to Prepare Feasibility Studies at RSA Unit 1, Unit 2, and Various Sites at Unit 3, Redstone Arsenal*, (ESE, 1994). A RCRA CMS has previously been conducted for the site (ESE, 1993). Information gathered during the CMS, as applicable, will be used during preparation of the FS.

PROJECT ORGANIZATION





SCHEDULE OF ACTIVITIES REDSTONE ARSENAL

SECTION 6

PLANS AND MANAGEMENT

6.0.a This section presents the schedule for RI activities and identifies key project personnel.

6.1 SCHEDULING

6.1.a The anticipated schedule of activities is presented as Figure 6-1. The schedule of deliverables is as follows:

Deliverable	Date
<i>Draft</i> - Site Characterization Report for Sites RSA-66 and RSA-68	4/25/97
<i>Draft Final</i> - Site Characterization Report for Sites RSA-66 and RSA-68	6/6/97
<i>Final</i> - Site Characterization Report for Sites RSA-66 and RSA-68	7/25/97
Task Order completion date	9/30/97

6.2 STAFFING

6.2.a Key Parsons ES personnel on this project are:

- Thomas M. Roth, P.E. Project Manager;
- Ken Stockwell, P.E. Technical Director;
- Ronda Simmons, Ph.D, P.G. Field Team Leader, RSA-53, -60, -66, -68;
- Alyse Getty Risk Assessment Coordinator;
- Janet Hall Quality Assurance Officer, Data Coordinator;
- Ed Grunwald Health and Safety Officer.

6.2.b The project organization is shown on Figure 6-2.

SECTION 7

REFERENCES

- Environmental Science & Engineering (ESE). 1995. Internal-Draft Baseline Risk Assessment for RSA-10, RSA-53, and RSA-60. Redstone Arsenal, Alabama. Prepared for U.S. Army Corps of Engineers, Huntsville Division. Contract No. DACA-87-92-D-0018.
- Environmental Science and Engineering (ESE), 1994. Final Work Plan to Prepare Feasibility Studies at RSA Unit 1, Unit 2, and Various Sites at Unit 3, Redstone Arsenal. Prepared for U.S. Army Corps of Engineers, September 1994.
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- Geraghty and Miller (G & M). 1992a. Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Prepared for the U.S. Army Corps of Engineers, Huntsville Division. Contract No. DACA87-89-C-0075.
- Geraghty and Miller (G & M). 1992b. Quality Control Summary Report, Phase II RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Report Prepared for the U.S. Army Corps of Engineers, October 1992.
- LaMoreaux, P. E. and Associates (PELA). 1988a. Confirmation Report, Unit 3 Investigations, Redstone Arsenal, Alabama. Volumes I through VI. Report Prepared for U.S. Army Corps of Engineers, July 1988.

DRAFT FINAL
Group X4B(u)
Site Specific Work Plan
(RSA 66, RSA-68)
Redstone Arsenal, Alabama

LaMoreaux, P. E. and Associates (PELA). 1988b. Remedial Investigation Engineering Report, Redstone Arsenal, Alabama, Unit 1 DDT and Sanitary Landfills and Unit 2 Open Burn/Demolition Area. Volumes I through VII. Consulting Report Prepared for U.S. Army Corps of Engineers, September 1988.

LaMoreaux, P. E. and Associates (PELA). 1989. Upgrade Confirmation Report and Assessment of Remedial Alternatives for Selected Unit 3 Sites, Redstone Arsenal, Alabama. Volumes I through V. Report Prepared for U.S. Army Corps of Engineers, April 1989.

Parsons Engineering Science, 1996. Draft Final General RI/FS Work Plan for Unit 2 and Group X4B Sites. Prepared for U.S. Army Corps of Engineers Huntsville Center, September 1996.

United States Army Corps of Engineers (USACE). 1994. Revised Final Work Plan to Prepare Baseline Risk Assessments at 16 SWMUs, Redstone Arsenal. Report Prepared for U.S. Army Missile Command, Redstone Arsenal, September 1994.

APPENDIX A
SITE SPECIFIC SAFETY AND HEALTH PLAN

**SITE SPECIFIC SAFETY AND HEALTH PLAN
FOR SITES RSA-66 AND RSA-68 (GROUP X4U)
REDSTONE ARSENAL, ALABAMA**

PREPARED FOR

**U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER**
Huntsville, Alabama

Contract No. DACA 87-95-D0018
Task Order No. 0005

PREPARED BY

PARSONS ENGINEERING SCIENCE, INC
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June 1996

Reviewed and Approved:

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Project Manager

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SECTION 1

PURPOSE AND POLICY

1.0.a The purpose of this Site Safety and Health Plan (SSHP) is to identify safety and health policies, practices, and procedures to be followed during field activities at Sites RSA-66 and RSA-68 (former testing and ash disposal area and former industrial waste landfill) at Redstone Arsenal, Alabama. The site activities will be conducted in support of a remedial investigation/feasibility study (RI/FS) under Delivery Order 0005 of Contract Number DACA87-95-D-0018. All work performed under this contract will be in compliance with the Ordnance Management Plan (Appendix C, Generic RI/FS Work Plan, Parsons ES, 1996).

1.0.b The provisions of this Plan represent mandatory minimum requirements for activities conducted during the field work at these sites. This Plan meets the requirements of the Occupational Safety and Health Administration's (OSHA) final rule on Hazardous Waste Operations and Emergency Response (29 CFR 1910.120). Any supplemental plans used by subcontractors shall conform to this Plan as a minimum. The provisions of this Plan are applicable to Parsons Engineering Science (Parsons ES) personnel and subcontractors. Personnel who engage in activities covered by this Plan shall be familiar with its contents and comply with its requirements.

1.0.c This SSHP is supplemented with a generic Safety and Health Plan (SHP) (Parsons ES, 1996). As previously described, the SSHP provides site- and activity-specific S&H protocols and procedures to be used during field operations at RSA-66 and RSA-68. The SHP establishes *general* personnel protective standards, safety practices, and safety procedures for use during all remedial investigation/feasibility study (RI/FS) activities at Redstone Arsenal. The generic document is intended to provide guidance to contractors in preparing the SSHP, stipulate consistent S&H related activities for the site, and aid in the cost-effective production of SSHPs.

SECTION 2

PROJECT TEAM ORGANIZATION

2.0.a The following personnel are designated to perform the stated job function for this project:

Project Manager	Tom Roth, P.E.
Project Safety & Health Officer	Ed Grunwald, C.I.H.
Site Safety & Health Officer	Cindy Lewis
Field Team Leader	Ronda Simmons, Ph.D., P.G.
Field Team Member	TBD

Table 2.1 Field Activities Supporting RI/FS
RSA-66 and RSA-68
Redstone Arsenal
Project Team Responsibilities

Title	General Description	Responsibilities
Project Manager	Reports to upper-level management. Has authority to direct response operations. Controls site activities.	<ul style="list-style-type: none"> • Ensures that the Work Plan is completed on schedule. • Serves as the liaison with public officials. • Uses the Project Safety and Health Officer to ensure that safety and health requirements are met. • Assigns personnel to develop Work Plan and Site Safety and Health Plan (SSHHP). • Coordinates activities with appropriate officials. • Briefs the field team on specific assignments. • Prepares the final report and support files on the response activities.
Project Safety and Health Officer	Advises the Project Manager on all aspects of safety and health.	<ul style="list-style-type: none"> • Confirms each team member's suitability based upon training and medical surveillance report. • Develops Site Safety and Health Plan • Selects Site Safety and Health Officer • Conducts periodic inspections to determine if the SSHHP is being followed.
Site Safety and Health Officer	Informs Project Safety and Health Officer of site safety and health issues. Stops work if any operation threatens workers or public.	<ul style="list-style-type: none"> • Periodically inspects protective clothing and equipment. • Conducts daily safety and health inspections. • Maintains a safety and health logbook. • Ensures that protective clothing and equipment are properly stored and maintained. • Monitors the work parties for signs of stress, such as cold stress and fatigue. • Implements the SSHHP. • Enforces the "buddy" system.

Table 2.1 (Continued) Field Activities Supporting RI/FS
RSA-66 and RSA-68
Redstone Arsenal
Project Team Responsibilities

Title	General Description	Responsibilities
Site Safety and Health Officer (Continued)		<ul style="list-style-type: none"> • Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department. • Ensures decontamination lines and decontamination solutions are appropriate for the type of chemical contamination on the site. • Controls the decontamination of all equipment, personnel and samples from the contaminated areas. • Assures proper disposal of contaminated clothing and materials.
Field Team Leader	Responsible for field team operations.	<ul style="list-style-type: none"> • Manages field operations. • Executes the Work Plan. • Enforces safety procedures. • Coordinates with the Onsite Safety and Health Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as a site liaison with public officials. • Controls entry and exit at the Access Control Points.
Field Team Members	Other ES personnel and subcontractor entering site to conduct activities covered by plan.	<ul style="list-style-type: none"> • Safely complete the onsite tasks required to fulfill the Work Plan. • Read and comply with SSHP. • Notify Onsite Safety and Health Officer or Field Team leader of suspected unsafe conditions. • Practice the "buddy" system.

SECTION 3

SITE DESCRIPTIONS AND SCOPE OF WORK

3.0.a Parsons ES has been contracted by the U.S. Army Corps of Engineers, Huntsville District (CESHND) to conduct field activities supporting remedial investigation/feasibility studies at two sites at Redstone Arsenal (RSA). The sites included under this phase of activities are:

- RSA-66, Former Testing and Ash Disposal Area; and
- RSA-68, Former Industrial Waste Landfill.

3.0.b The locations and descriptions of the study sites are provided in the RSA-66 and 68 RI/FS Work Plan. The following sections summarize the scope of work to be performed and provide background information on each of the areas to be visited. This information was excerpted from ESE 1996.

3.1 SCOPE OF WORK

3.1.a The scope of work covered by this SSHP includes:

- installation of deep overburden and upper and lower bedrock groundwater monitoring wells; boring will be conducted by drill rig and mud rotary methods;
- groundwater level measurements;
- groundwater sampling;
- surface water sampling;
- sediment sampling; and
- soil sampling using hand augers and split spoons;

3.1.b These activities will be conducted in order to provide sufficient data for completion of a baseline risk assessment and remedial action feasibility study for RSA-66 and RSA-68. Field activities should be conducted in winter and should be completed within three months.

3.2 RSA-66, FORMER TESTING AND ASH DISPOSAL AREA

3.2.a RSA-66 occupies roughly 20 acres of land in the southern part of RSA on the floodplain about 1,700 feet east of the Tennessee River. It is approximately 2,000 feet west of RSA-68 and 1,800 feet north of the Open Burn/Open Detonation Area. RSA-66 has small ponds and wetlands covering the northern portion, grass covering the eastern portion, and woods covering the western portion of the area.

3.2.b The land was used from the 1950s through the 1970s to dispose ash, residue, and debris from open burning of wastes at Unit 2. Disposal operations were reportedly confined to the western portion of the area. Most of the waste is currently covered by soil, grass, and weeds. Drums, bottles of unidentified chemicals, ordnance, Mustard Gas test kits, a safety shower, old detonation lines, and bunkers have been found in the past at the site. Since the 1970s, the area has been surface-cleared and has restricted access. No remediation has been conducted at RSA-66.

3.3 RSA-68, FORMER INDUSTRIAL WASTE LANDFILL

3.3.a RSA-68 occupies 5 to 10 acres and is located in the southern portion of RSA, less than one mile east of the Tennessee River. It is located directly north of Area Y (the former storage area for Mustard Gas), approximately 2,000 feet east of RSA-66 and 3,500 feet northeast of the Open Burn/Open Detonation Area. On the west, RSA-68 is bounded by a low-lying forested area, igloo ponds, and associated drainage ditches. The topography of the area is nearly flat, with surface drainage controlled by ditches east and west of the site and wetlands to the north. Vegetation at the site consists primarily of small pines, briars, and grasses.

3.3.b RSA-68 is a former chemical waste and disposal area. The dump was used from the 1950s to 1980 for demilitarization of high explosives. It was also used for the disposal of inhibited red fuming nitric acid, cyanide, chromium, metallic salts, chlorine trifluoride, beryllium, and laboratory chemicals. Explosives were detonated or burned on the land surfaces and wastes were disposed in trenches. The area has been surface cleared and access has been restricted. No remediation has been conducted at RSA-68.

SECTION 4

PHYSICAL AND CHEMICAL HAZARD ANALYSIS

4.0.a This section describes the physical and chemical hazards associated with the field investigations at RSA-66 and RSA-68. General hazards and S&H concerns are addressed in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan.

4.1 PHYSICAL AND CHEMICAL HAZARDS AT RSA-66 AND RSA-68

4.1.a Field activities planned for RSA-66 and RSA-68 (to include, groundwater sampling, surface water sampling, and sediment sampling) could result in employee exposure via several pathways, including inhalation exposure to volatiles and semi- and non-volatiles adhering to particulates. In addition, it is possible that recovered chemical warfare material or unexploded ordnance may be encountered during field activities at this area. Parsons ES personnel will not touch or handle any recovered chemical warfare or unexploded ordnance material.

4.1.b General pathways for exposure during field investigation activities at these sites along with potential chemical and physical hazards are included in Table 4.1 of Appendix A (General Safety and Health Plan) in the General RI/FS Work Plan.

4.1.c Extensive monitoring data are available for this site. Previous studies have evaluated existing data and determined exposure point concentrations for each detected compound at the site. If a sufficient number of data points existed, these exposure point concentrations represent the 95% upper confidence limit. If an insufficient number of data points existed, the exposure point concentration is the maximum concentration detected. Because these exposure point evaluations represent the outcome of extensive evaluation of all data collected to date, and they represent worst case concentrations, they are appropriate for use in evaluating potential health and safety hazards and determining protective personal protective equipment.

4.1.d Exposure point concentrations of chemicals of potential concern during the proposed activities at RSA-66 and RSA-68 are provided in Tables 4.1 and 4.2. The chemicals identified on this table as potential concerns represent a subset of those detected at the site. The full range of detected chemicals is included in Appendix A.

4.1.e The chemicals of potential concern were selected based on evaluation of the physicochemical characteristics, permissible exposure limits, and toxicological properties combined with the concentrations in various media. These properties are presented in the generic SHP. No additional chemicals of potential concern have been identified for this site. As noted in Tables 4.1 and 4.2, only volatile compounds in groundwater and recovered chemical warfare material present potential health and safety concerns at this area. The low concentrations detected in groundwater result in a low potential for exposure from that medium.

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RSA 66 & 68 (Group X4B(u))
Safety and Health Plan
Redstone Arsenal, Alabama

Table 4.1 Exposure Point Concentrations of Chemicals of Potential Concern at RSA-66

MEDIA	CHEMICAL	CONCENTRATION
Groundwater	1,2 dichloroethene	0.194 mg/l
	tetrachloroethane	0.0635 mg/l
	tetrachloroethene	0.0903 mg/l
	trichloroethene	0.1047 mg/l

Notes:

*Exposure point concentrations were extracted from ESE, 1996. They represent the 95% UCL value of concentrations detected during the Phase I and II investigations, as determined and reported by ESE. If the number of samples precluded determination of the 95% UCL, the maximum values were reported.

SECTION 5

PERSONAL PROTECTIVE EQUIPMENT

5.0.a Personal protective equipment to be employed at the initial stage of each planned activity at RSA-66 and RSA-68 is shown in Tables 5.1 and 5.2, respectively. The appropriate equipment to be used for each respective PPE level is provided in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan. The level of PPE employed at each activity is subject to change, based on the results of real-time air monitoring, as stipulated in Section 6.

TABLE 5.1
PERSONAL PROTECTIVE EQUIPMENT LEVEL FOR RSA-66

Activity	PPE Level
Installing groundwater monitoring wells	D
Measuring groundwater level	D
Sampling groundwater	D
Sampling soil	D
Biota sampling	D

TABLE 5.2
PERSONAL PROTECTIVE EQUIPMENT LEVEL FOR RSA-68

Activity	PPE Level
Installing groundwater monitoring wells	D
Measuring groundwater level	D
Sampling groundwater	D
Sampling soil	D
Biota sampling	D

SECTION 6

AIR MONITORING AND ACTION LEVELS

6.0.a Air monitoring to be conducted during field activities at RSA-66 and RSA-68 has been determined in accordance with the guidelines in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan. In addition, for each potential exposure pathway, worst case air concentrations were calculated and compared with the permissible exposure limits to evaluate the potential for overexposure to one or a combination of similar acting chemicals during each phase of activity. Air monitoring requirements were then determined based on that evaluation.

6.0.b It is possible that recovered chemical warfare material (RCWM) may be encountered at both of these areas. Air monitoring for the presence of RCWM will be conducted by ERDC and is not included in this SSHP.

6.1 AIR MONITORING AT RSA-66

6.1.a Evaluation of potential worst case air concentrations based on concentrations of contaminants detected in groundwater at RSA-66 indicate that a low potential exists for exposure to combined volatile components exceeding the permissible exposure limits. Therefore, in accordance with the requirements in the generic SHP, air monitoring will be conducted utilizing OVA (FID) during all activities involving contact with groundwater, including well installation, water level measurements, and sampling. Of the chlorinated organics detected in the groundwater at this site, tetrachloroethane has the lowest permissible exposure limit, at 1 ppm. That PEL will, therefore, serve as the action level for triggering increased respiratory protection.

Concentration of Organic Vapors in the Breathing Zone over Background	Level of Respiratory Protection
0 - 1 ppm	D
1 ppm - 100 ppm	C
100 ppm - 1,000 ppm	B

6.1.b Evaluation of concentrations detected in other media (soil, surface water, and sediment) indicate that no potential exists for exceeding permissible exposure limits during the proposed activities. Therefore, no additional air monitoring is warranted at this site. However, care will be taken to avoid particulate (both water and soil) generation during mud rotary drilling.

6.2 AIR MONITORING AT RSA-68

6.2.a Evaluation of potential worst case air concentrations based on concentrations of contaminants detected in groundwater at RSA-68 indicate that the potential exists for exposure exceeding the permissible exposure limit to chlorinated volatiles, including vinyl chloride. Therefore, vinyl chloride will be selected as the indicator chemical during real-time monitoring of field activities contacting groundwater at RSA-68. Air monitoring requirements and the associated action levels are provided below.

Concentration of Organic Vapors in the Breathing Zone over Background	Level of Respiratory Protection
0 - 1 ppm	D
1 ppm - 10 ppm	C
10 ppm - 500 ppm	B
>500 ppm	stop work; reevaluate activities
50 ppm - 500 ppm	B

6.2.b In addition, although concentrations of pesticides and semivolatiles in sediments are sufficiently low that air monitoring for volatile components or dust is not warranted, because of the highly toxic and persistent nature of these compounds, measures will be taken to ensure that the sediments remain damp, to avoid dust generation during their handling.

APPENDIX A.1
EXPOSURE POINT CONCENTRATIONS

Human Exposure Concentrations Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-66	Groundwater	Acetone	ACET	5.59E-01	mg/L	UCL95	I/II
		Arsenic	AS	4.10E-03	mg/L	UCL95	I
		Barium	BA	8.80E-01	mg/L	UCL95	I
		Cadmium (aqueous matrix)	CD-A*	9.50E-03	mg/L	UCL95	I
		Chromium	CR	1.99E-01	mg/L	UCL95	I
		Dichloroethane, 1,1-	11DCLE	4.18E-02	mg/L	UCL95	I/II
		Dichloroethane, 1,2-	12DCLE	2.60E-03	mg/L	UCL95	I/II
		Dichloroethane, 1,2- (total)	12DCE	1.95E-01	mg/L	UCL95	I/II
		Lead	PB	2.82E-02	mg/L	UCL95	I
		Mercury	HG	1.70E-03	mg/L	UCL95	I
		Tetrachloroethane, 1,1,2,2-	TCLEA	6.35E-02	mg/L	UCL95	I/II
		Tetrachloroethene	TCLEE	9.03E-02	mg/L	UCL95	I/II
		Toluene	MEC6H5	4.20E-03	mg/L	UCL95	I/II
		Trichloroethane, 1,1,1-	111TCE	3.80E-03	mg/L	UCL95	I/II
		Trichloroethane, 1,1,2-	112TCE	3.30E-03	mg/L	UCL95	I/II
		Trichloroethene	TRCLE	1.05E-01	mg/L	UCL95	I/II
	Sediment	Acetone	ACET	3.90E-02	mg/kg	max	I
		Arsenic	AS	3.20E+00	mg/kg	max	I
		Barium	BA	1.43E+02	mg/kg	max	I
		Chromium	CR	1.87E+01	mg/kg	max	I
		Lead	PB	2.11E+01	mg/kg	max	I
		Toluene	MEC6H5	6.00E-03	mg/kg	max	I
	Shallow Soil	Acetone	ACET	3.30E-02	mg/kg	UCL95	I
		Benzoic acid	BENZOA	4.60E-01	mg/kg	max	I
		Bis(2-ethylhexyl) phthalate	B2EHP	2.46E+01	mg/kg	UCL95	I
		Methylene chloride	CH2CL2	1.30E-02	mg/kg	UCL95	I
	Surface Water	Acetone	ACET	2.70E-02	mg/L	max	I
		Arsenic	AS	6.00E-03	mg/L	max	I
		Barium	BA	2.25E-02	mg/L	max	I
RSA-68	Groundwater	Acetone	ACET	1.77E-01	mg/L	UCL95	I/II
		Arsenic	AS	2.31E-03	mg/L	UCL95	I/II
		Barium	BA	2.37E-01	mg/L	UCL95	I/II
		Butanone, 2-	MEK	6.39E-03	mg/L	UCL95	I/II
		Cadmium (aqueous matrix)	CD-A*	7.51E-03	mg/L	UCL95	I/II
		Carbon tetrachloride	CCL4	3.66E-03	mg/L	UCL95	I/II
		Chloroform	CHCL3	7.01E-03	mg/L	UCL95	I/II
		Chromium	CR	7.86E-03	mg/L	UCL95	I/II
		Dichloroethane, 1,1-	11DCLE	2.00E-03	mg/L	max	I/II
		Dichloroethene, 1,1-	11DCE	2.88E-03	mg/L	UCL95	I/II
		Dichloroethene, 1,2- (total)	12DCE	1.01E-01	mg/L	UCL95	I/II
		Dichloropropane, 1,2-	12DCLP	2.00E-03	mg/L	max	I**
		HMX	HMX	2.26E-03	mg/L	UCL95	I/II
		Lead	PB	6.86E-03	mg/L	UCL95	I/II
		Mercury	HG	1.20E-04	mg/L	UCL95	I/II
		RDX	RDX	2.73E-03	mg/L	UCL95	I/II
		Selenium	SE	2.00E-03	mg/L	max	II**
		Tetrachloroethane, 1,1,2,2-	TCLEA	1.03E+00	mg/L	UCL95	I/II
		Tetrachloroethene	TCLEE	8.12E-02	mg/L	UCL95	I/II
		Toluene	MEC6H5	2.00E-03	mg/L	max	II**
		Trichloroethane, 1,1,1-	111TCE	2.54E-03	mg/L	UCL95	I/II
		Trichloroethane, 1,1,2-	112TCE	9.48E-03	mg/L	UCL95	I/II
		Trichloroethene	TRCLE	1.91E+00	mg/L	UCL95	I/II
		Triatobenzene, 1,3,5-	135TNB	1.00E-03	mg/L	UCL95	I/II
		Vinyl chloride	C2H3CL	5.00E-03	mg/L	max	I**

Human Exposure Concentrations Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-68 (Continued)	Sediment	Acetone	ACET	2.17E-01	mg/kg	UCL95	I
		Barium	BA	1.17E+02	mg/kg	UCL95	I
		Benzoic acid	BENZOA	3.00E+00	mg/kg	max	I
		Bis(2-ethylhexyl) phthalate	B2EHP	1.70E-01	mg/kg	max	I
		Carbon tetrachloride	CCL4	2.02E-02	mg/kg	UCL95	I
		Chromium	CR	2.58E+01	mg/kg	UCL95	I
		DDE, 4,4'	PPDDE	1.00E-02	mg/kg	max	I
		Diethyl phthalate	DEP	2.40E-01	mg/kg	max	I
		Lead	PB	1.80E+01	mg/kg	max	I
		Methylene chloride	CH2CL2	1.29E-01	mg/kg	UCL95	I
		Pentachlorophenol	PCP	6.40E-01	mg/kg	max	I
		Selenium	SE	1.40E+00	mg/kg	UCL95	I
	Shallow Soil	Acetone	ACET	3.60E-02	mg/kg	max	I
		Methylene chloride	CH2CL2	2.00E-02	mg/kg	max	I
	Surface Water	Acetone	ACET	3.60E-02	mg/L	max	I
		Barium	BA	3.76E-02	mg/L	max	I
		DDT, 4,4'	PPDDT	1.90E-04	mg/L	max	I
		Heptachlor	HPCL	7.00E-05	mg/L	max	I
		Lindane	LIN	5.00E-05	mg/L	max	I
		Methylene chloride	CH2CL2	7.00E-03	mg/L	max	I
		Selenium	SE	3.60E-03	mg/L	max	I
Unit 2	Groundwater	Acetone	ACET	1.71E-01	mg/L	UCL95	I/II
		Arsenic	AS	3.57E-03	mg/L	UCL95	I
		Barium	BA	1.38E-01	mg/L	UCL95	I
		Benzene	C6H6	1.99E-02	mg/L	UCL95	I/II
		Bis(2-chloroethoxy)methane	B2CEXM	5.51E-03	mg/L	UCL95	I
		Bis(2-ethylhexyl) phthalate	B2EHP	2.13E-02	mg/L	UCL95	I
		Cadmium (aqueous matrix)	CD-A*	4.91E-03	mg/L	UCL95	I
		Carbon tetrachloride	CCL4	3.92E-03	mg/L	UCL95	I/II
		Chlorobenzene	CLC6H5	5.58E-03	mg/L	UCL95	I/II
		Chloroform	CHCL3	5.22E-02	mg/L	UCL95	I/II
		Chloromethane	CH3CL	6.82E-03	mg/L	UCL95	I/II
		Chromium	CR	1.52E-02	mg/L	UCL95	I
		Dichloroethane, 1,1-	11DCLE	1.25E-02	mg/L	UCL95	I/II
		Dichloroethane, 1,2-	12DCLE	8.75E-03	mg/L	UCL95	I/II
		Dichloroethane, 1,1-	11DCE	1.05E-01	mg/L	UCL95	I/II
		Dichloroethane, 1,2- (total)	12DCE	2.13E+00	mg/L	UCL95	I/II
		Dinitrobenzene, 1,3	13DNB	7.20E-04	mg/L	UCL95	I
		Dinitrotoluene, 2,4	24DNT	4.90E-03	mg/L	max	I
		Ethylbenzene	ETC6H5	3.48E-03	mg/L	UCL95	I/II
		Lead	PB	6.18E-03	mg/L	UCL95	I
		Mercury	HG	3.60E-04	mg/L	UCL95	I
		Methylene chloride	CH2CL2	2.00E-02	mg/L	UCL95	I/II
		Phenol	PHENOL	5.46E-03	mg/L	UCL95	I
		RDX	RDX	5.88E-03	mg/L	UCL95	I
		Selenium	SE	2.79E-03	mg/L	UCL95	I
		Tetrachloroethane, 1,1,2,2-	TCLEA	5.63E-03	mg/L	UCL95	I/II
		Tetrachloroethene	TCLEE	4.09E-02	mg/L	UCL95	I/II
		Toluene	MEC6H5	3.96E-03	mg/L	UCL95	I/II
		Trichloroethane, 1,1,1-	111TCE	8.28E-02	mg/L	UCL95	I/II
		Trichloroethane, 1,1,2-	112TCE	4.25E-03	mg/L	UCL95	I/II
		Trichloroethene	TRCLE	4.85E+00	mg/L	UCL95	I/II
		Trinitrobenzene, 1,3,5-	135TNB	3.52E-02	mg/L	UCL95	I
		Vinyl chloride	C2H3CL	4.03E-02	mg/L	UCL95	I/II
		Xylenes (total)	XYLEN	2.96E-02	mg/L	UCL95	I/II

Human Exposure Concentrations Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
Unit 2 (Continued)	Sediment	Arsenic	AS	8.00E+00	mg/kg	UCL95	I
		Barium	BA	2.50E+02	mg/kg	UCL95	I
		Cadmium (solid matrix)	CD-S*	4.60E+00	mg/kg	UCL95	I
		Chromium	CR	2.44E+01	mg/kg	UCL95	I
		DNT, 2,6-	26DNT	5.00E-01	mg/kg	UCL95	I
		Ethylbenzene	ETC6H5	1.01E-02	mg/kg	UCL95	I
		HMX	HMX	3.10E+00	mg/kg	UCL95	I
		Lead	PB	2.99E+01	mg/kg	UCL95	I
		PETN	PETN	4.30E+00	mg/kg	UCL95	I
Shallow Soil***	Acetone	Acetone	ACET	3.70E+01	mg/kg	max	II**
		Bis(2-ethylhexyl) phthalate	B2EHP	3.30E-01	mg/kg	max	I
		Chloroform	CHCL3	1.70E-02	mg/kg	max	II**
		Di-n-butyl phthalate	DNBP	3.80E-01	mg/kg	max	I
		Dichloroethane, 1,1-	11DCLE	1.30E-02	mg/kg	max	II**
		Dichloroethane, 1,2- (total)	12DCE	1.20E+00	mg/kg	max	II**
		Dinitrotoluene, 2,4-	24DNT	8.39E-01	mg/kg	max	I
		HMX	HMX	9.06E-01	mg/kg	max	I
		Methylene chloride	CH2CL2	2.60E+00	mg/kg	max	I**
		PETN	PETN	2.23E+01	mg/kg	max	I
		RDX	RDX	1.43E+00	mg/kg	max	I
		Tetrachloroethene	TCL2E	9.70E+00	mg/kg	max	I**
		Toluene	MEC6H5	7.00E-03	mg/kg	max	II**
		Trichloroethene	TRCLE	1.30E+01	mg/kg	max	I**
		Trinitrobenzene, 1,3,5-	135TNB	1.16E+00	mg/kg	max	I
		Trinitrotoluene, 2,4,6-	246TNT	8.57E+02	mg/kg	max	I
Surface Water	Acetone	Acetone	ACET	1.54E-02	mg/L	UCL95	I
		Barium	BA	4.65E-02	mg/L	UCL95	I
		Lead	PB	1.10E-03	mg/L	UCL95	I
		Trichloroethene	TRCLE	4.20E-03	mg/L	UCL95	I

Note: I = Samples were analyzed for this chemical during Phase I only.
UCL95 or maximum was obtained from Phase I sample results.
II = Samples were analyzed for this chemical during Phase II only.
UCL95 or maximum was obtained from Phase II sample results.
I** = Samples were analyzed for this chemical during both Phases I and II.
Maximum was obtained from Phase I sample results.
II** = Samples were analyzed for this chemical during both Phases I and II.
Maximum was obtained from Phase II sample results.
I/II = Samples were analyzed for this chemical during both Phases I and II.
UCL95 or maximum was obtained from both Phase I and Phase II sample results.
*** = Maximum values from Phase I and/or II samples were used exclusively for Unit 2 shallow soil ECs.
The Phase II RPT (G&M, 1992a) did not provide UCL95s for all Phase I and II data combined.
See Data Uncertainties section of report for further discussion.

EC = exposure concentration
UCL95 = 95% upper confidence limit
max = maximum concentration

Human Exposure Concentrations for Fish Used in Analyses

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-68	Fish	Acetone	ACET	2.14E-02	mg/kg	only	I
		Barium	BA	3.46E-01	mg/kg	only	I
		DDT, p,p'-	PPDDT	1.03E+01	mg/kg	only	I
		Heptachlor	HPCL	1.10E+00	mg/kg	only	I
		Lindane	LIN	6.50E-03	mg/kg	only	I
		Methylene chloride	CH2CL2	3.50E-02	mg/kg	only	I
		Selenium	SE	8.80E-01	mg/kg	only	I
Unit 2	Fish	Acetone	ACET	3.45E-03	mg/kg	only	I
		Barium	BA	3.33E-01	mg/kg	only	I
		Lead	PB	8.50E-02	mg/kg	only	I
		Trichloroethene	TRCLE	1.95E-01	mg/kg	only	I

Note: These exposure concentrations are derived from one of two samples taken from close to the river or in the Igloo Pond.

One sample is the Phase I surface water sample, SW-Z-5 (pond), and the other sample is 2-SW-5 (near river).

only = Exposure concentration was derived from one sample concentration.

ACCIDENT REPORT FORM (continued)

OTHER

20. Name and address of physician: _____

21. If hospitalized, name and address of hospital: _____

Date of report _____ Prepared by _____

Official position _____

ACCIDENT REPORT FORM

Project: Redstone Arsenal RI/FS

EMPLOYER

1. Name: _____
2. Mail Address: _____
(No. and Street) (City or Town) (State)
3. Location, if different from mail address: _____

INJURED OR ILL EMPLOYEE

4. Name _____ Social Security Number: _____
(First) (Middle) (Last)
5. Home Address: _____
(No. and Street) (City or Town) (State)
6. Age _____ 7. Sex: Male _____ Female _____ (Check one)
8. Occupation: _____
(Specific job title, not the specific activity employee was performing at time of injury)
9. Department: _____
(Enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure: _____
(No. and Street) (City or Town) (State)
11. Was place of accident or exposure on employer's premises? (Yes/No)
12. What was the employee doing when injured? _____
(Be specific - Was employee using tools or equipment or handling material?)

ACCIDENT REPORT FORM *(continued)*

13. How did the accident occur? _____

(Describe fully the events which resulted in the injury or occupational illness. Tell what happened and how. Name objects and substances involved. Give details on all factors which led to accident. Use separate sheet for additional space.)

14. Time of accident: _____

15. Witnesses to accident:

(Name) (Affiliation) (Phone No.)

(Name) (Affiliation) (Phone No.)

(Name) (Affiliation) (Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe the injury or illness in detail and indicate the part of the body affected.

17. Name the object or substance which directly injured the employee. (For example, object which struck employee; the vapor or poison inhaled or swallowed; the chemical or radiation which irritated the skin; or in cases of strains, hernias, etc., the object the employee was lifting, pulling, etc.). _____

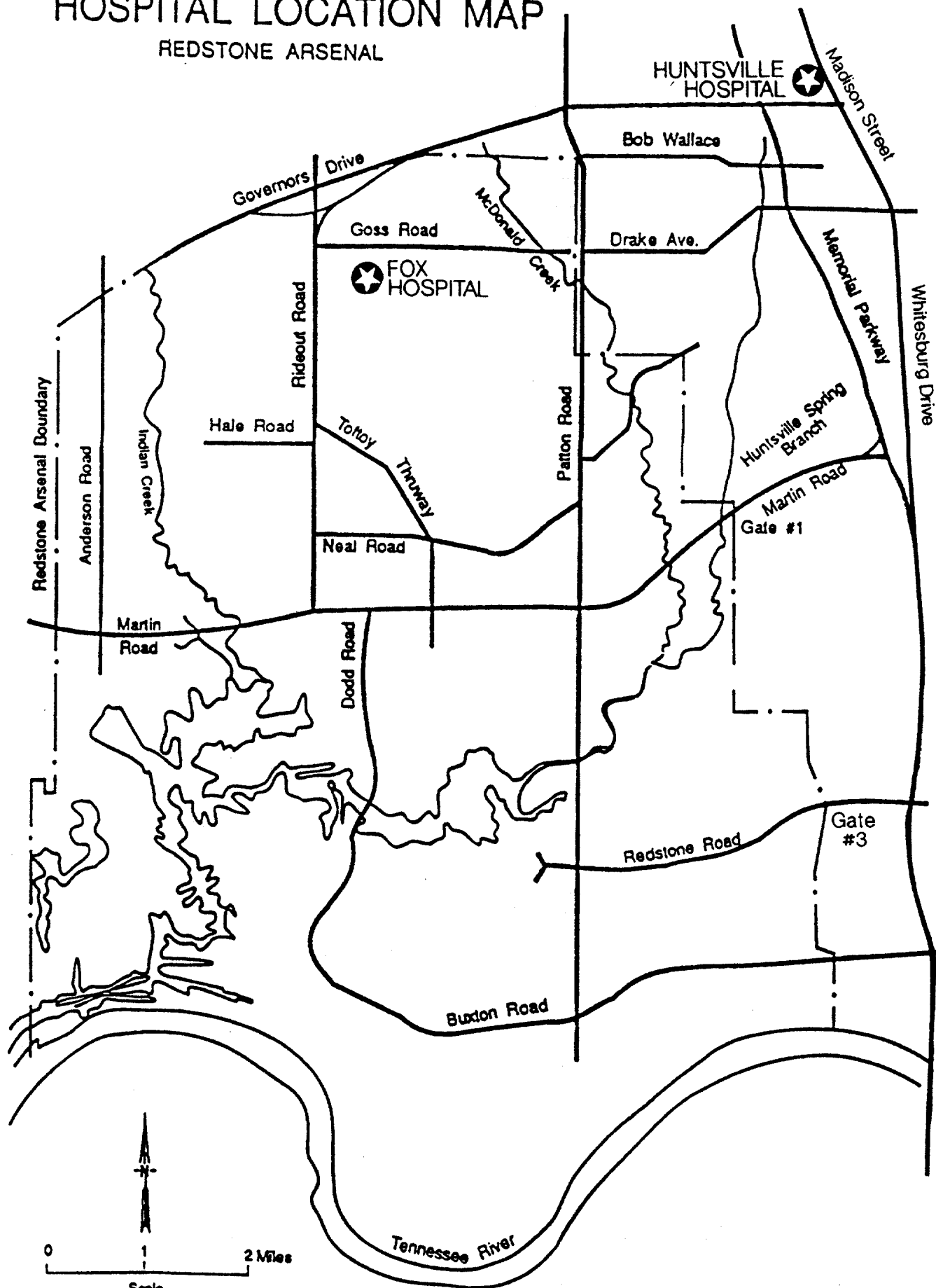
18. Date of injury or initial diagnosis of occupational illness: _____
(Date)

19. Did the accident result in employee fatality? _____ (Yes or No)

APPENDIX A.4
ACCIDENT REPORT FORM

HOSPITAL LOCATION MAP

REDSTONE ARSENAL



APPENDIX A.3
MAP TO NEAREST HOSPITAL

**PLAN ACCEPTANCE FORM
PROJECT SAFETY AND HEALTH PLAN**

I have read and agree to abide by the contents of the Safety and Health Plan for the following project:

Field Work Supporting RI/FS Activities at RSA-66 and RSA-68

Redstone Arsenal

Name (print)

Signature

Date

Return to Onsite Safety and Health Officer before starting work at the site.

APPENDIX A.2
PLAN ACCEPTANCE FORM

Human Exposure Concentrations Used for Recreational Scenario at RSA-68

Area	Medium	Chemical Name	Chemical Code	Exposure Concentration	Units	EC is Max or UCL95	Phase from which EC Obtained
RSA-68	Sediment	Acetone	ACET	1.30E-01	mg/kg	only	I
		Bis(2-ethylhexyl) phthalate	B2EHP	3.15E-01	mg/kg	only	I
		Barium	BA	4.06E-02	mg/kg	only	I
		Benzoic acid	BENZOA	2.90E+00	mg/kg	only	I
		Carbon tetrachloride	CCL4	4.50E-03	mg/kg	only	I
		Methylene chloride	CH2CL2	1.00E-01	mg/kg	only	I
		Chromium	CR	2.69E-02	mg/kg	only	I
		Diethyl phthalate	DEP	3.15E-01	mg/kg	only	I
		Lead	PB	1.11E-02	mg/kg	only	I
		Pentachlorophenol	PCP	6.40E-01	mg/kg	only	I
		4,4'-DDE	PPDDE	2.50E-02	mg/kg	only	I
		Selenium	SE	6.10E-04	mg/kg	only	I
	Surface Water	Acetone	ACET	3.10E-02	mg/L	only	I
		Barium	BA	3.46E-02	mg/L	only	I
		Methylene chloride	CH2CL2	7.00E-03	mg/L	only	I
		Heptachlor	HPCL	7.00E-05	mg/L	only	I
		gamma-BHC (Lindane)	LIN	5.00E-05	mg/L	only	I
		4,4'-DDT	PPDDT	1.90E-04	mg/L	only	I
		Selenium	SE	2.20E-03	mg/L	only	I

Note: These exposure concentrations are derived from one of two samples taken from the Igloo Pond. One sample is the Phase I sediment sample, ZS-8, and the other sample is the Phase I surface water sample, SW-Z-5.

only = Exposure concentration was derived from one sample concentration.

APPENDIX B
FIELD SAMPLING PLAN

APPENDIX B

FIELD SAMPLING PLAN

B.0.a This Field Sampling Plan (FSP) presents the detailed sampling and testing methods for field activities to be conducted during the RI at Sites RSA-66 and RSA-68 (Group X4B(u)). The FSP will be used as a guide for the collection of precise, accurate, and representative field data.

B.1 INTRODUCTION AND SCOPE

B.1.a Standard operating procedures will be followed to minimize errors which could result in the collection of invalid data or nonrepresentative samples. Non-standard situations encountered in the field will be resolved by the Parsons ES Project Manager in consultation with the CEHNC Project Manager. The Alabama Department of Environmental Management and USEPA will be notified of any changes or situations that may require approvals.

B.1.b The tasks described in this FSP will be conducted while following health and safety procedures defined in the Installation Restoration Program Safety and Health Plan, which is located as Appendix A in the General RI/FS Work Plan, the Site Specific Safety Health and Plan (Appendix A) and the Monitoring Well Installation Plan and Field Investigation Plan which is located as Appendix D in the General RI/FS Work Plan. The following field activities will be conducted during the RI field effort at RSA-66 and RSA-69 (Group X4B(u)):

- Groundwater level measurements from 51 existing monitoring wells;
- Collection of 51 groundwater samples for chemical analysis;
- Collection of 8 surface water samples for chemical analysis;
- Collection of 8 sediment samples for chemical analysis; and
- Survey of horizontal locations of all sampling points.

B.2 FIELD EQUIPMENT AND SUPPLIES

B.2.a This section identifies parameters to be measured in the field. Calibration and maintenance of instruments used for field measurements are described below.

B.2.1 Field Parameters

B.2.1.a The following parameters may be measured in the field with the specified instruments:

- Temperature: Thermometer or temperature probe
- pH: Portable pH meter
- Conductivity: Portable conductivity meter
- Organic Vapors: Organic vapor analyzer (OVA) or photoionization detector (PID)
- Water Level: Electronic water level indicator
- Distance: Surveyor's tape measure or surveyed location

B.2.2 Field Equipment Calibration

B.2.2.a Each instrument will be calibrated following the manufacturer's recommendations or the standard operating procedures presented in this FSP. The acceptance criteria and corrective actions for each piece of equipment are as specified in the manufacturer's recommendations. An equipment calibration log sheet is provided in Attachment B-1.

B.2.3 Field Equipment Maintenance

B.2.3.a Equipment maintenance and repair will be performed as required for each instrument. Preventive maintenance for all equipment includes inspection before use, cleaning as necessary during use, and thorough cleaning and inspection after use. During the performance of field activities, all downhole augers, rods, and samplers will be visually inspected. Rechargeable batteries will be checked before use and recharged after use. For equipment using disposable batteries, replacement batteries will be stocked. Maintenance and repairs on field equipment will occur when corrective action needs are identified. If the instrument cannot be repaired (or re-calibrated), the instrument will be replaced.

APPENDIX C
CHEMICAL DATA ACQUISITION PLAN

APPENDIX C

CHEMICAL DATA ACQUISITION PLAN FOR GROUP X4B(u) SITES AT THE REDSTONE ARSENAL

C.1 CHEMICAL DATA ACQUISITION PLAN

C.1.a This appendix presents the Chemical Data Acquisition Plan (CDAP) for the Group X4B(u) Sites at the RSA.

C.1.1 Purpose and Scope of the CDAP

C.1.1.a The purpose of the CDAP is to document the quality assurance requirements applicable to the investigations at the Group X4B(u) Sites at the RSA. The scope of the CDAP includes the quality assurance and quality control criteria associated with the field sampling, field testing and laboratory analytical testing efforts of the investigations at the Group X4B(u) Sites at the RSA. The CDAP as presented herein applies to work performed at the Group X4B(u) RSA Sites or in any office or laboratory performing services for the investigations at Group X4B(u) Sites.

C.1.2 Contents of the CDAP

C.1.2.a The contents of this CDAP is limited to those elements not presented in the Field Sampling Plan (FSP) (Appendix B) and/or the General Work Plan (Parsons ES, 1996). The following list the required elements of the CDAP and the document that contains the element.

<u>Element</u>	<u>Location</u>
Project Description	FSP, B3
Project Organization and Responsibilities	FSP, B6
Data Quality Objectives	FSP, B3
Data Quality Objectives for Measurement Data	CDAP, Section C.2
Field Activities	FSP, B4
Sample Custody Procedures	General Work Plan QAPP, App. B.3
Calibration Procedures and Frequency	CDAP, Section C.3
Analytical Procedures	CDAP, Section C.4
Data Reduction Validation and Reporting	General Work Plan, Section 4
Internal Quality Control Checks	CDAP, Section C.5
Performance and System Audits	General Work Plan QAPP, App. A.7

Preventative Maintenance	General Work Plan QAPP, App. A.8
Formulas for Calculating Data Quality Indicators	General Work Plan QAPP, App. A.9
Corrective Action	General Work Plan QAPP, App. A.10
Quality Assurance Reports to Management	General Work Plan QAPP, App. A.11

C.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

C.2.a The overall objective of investigations at the RSA is to provide an accurate, precise, and representative summary of data necessary to fill in data gaps. The collected samples and the data generated from these samples and other site-generated data are intended to provide the information necessary to meet the site-specific data needs as defined in the Sections 3.5 and 3.6 of the Group X4B(u) Site Work Plan. This section describes data quality objectives (DQO) in terms of the precision, accuracy, representativeness, comparability and completeness (PARCC) requirements for the field and laboratory analyses for investigations at Group X4B(u) Sites at the RSA. Definitions and descriptions of PARCC parameters are contained in the General Plan QAPP (Parsons ES, 1996).

C.2.1 Field DQOs and PARCC Parameters

C.2.1.a All the field analyses are for screening data only. The requirements for the precision and accuracy are field duplicate samples, blanks and calibration of the equipment. Duplicates samples and blanks will be analyzed at a frequency of one for every ten samples or one per day, whichever is the most frequent. The calibration of the field equipment will be as specified by the instrument manufacture. The QC criteria for the field analyses is presented in Table C.1.

C.2.2 Laboratory DQOs and PARCC Parameters

C.2.2.a All the geotechnical and chemical laboratory analyses are for definitive data. The geotechnical data will be generating using ASTM methods. The QC requirements are defined in these methods. Targeted acceptable precision and accuracy QC limits for chemical analysis are dependent on the sample matrix and are defined in the CLP SOWs, SW846 Methods and summarized in Table 3.5 of the General Work Plan. Table C.2 presents the number and types of definitive investigative and quality control samples to be sampled and analyzed at the Group X4B(u) Sites.

C.3 CALIBRATION PROCEDURES AND FREQUENCY

C.3.a The calibration procedures and frequencies for field equipment will be as specified by the instrument manufacturer. The calibration procedures and frequencies for laboratory instruments shall be as specified in CLP SOWs and SW846 methods.

C.4 ANALYTICAL PROCEDURES

C.4.a The following discusses the field screening and laboratory definitive analysis of samples collected for chemical analysis during field sampling activities at the RSA.

C.4.1 Field Analyses

C.4.1.a Field screening analyses are listed in Section 3.5.

C.4.2 Field Measurement Procedures

C.4.2.a All field screening analyses shall be performed in accordance with written methods in this plan and the General RI/FS Work Plan (Parsons ES, 1996).

C.4.3 Laboratory Analyses

C.4.3.a The laboratory chemical and geotechnical analyses are listed in Section 3.5.

C.4.4 Laboratory Analytical Procedures

C.4.4.a Laboratory chemical and geotechnical analyses shall be performed according to the procedures contained in the CLP SOWs, SW846 and ASTM Methods.

C.5 INTERNAL QUALITY CONTROL CHECKS

C.5.a Internal QC checks are used to assess the quality of the field and laboratory analytical processes and provide a means to evaluate the need for corrective action. The internal QC checks for field analyses are:

- Field duplicate analyses;
- Field blanks; and
- Equipment calibrations.

C.5.b The USEPA CLP SOWs, SW846, and ASTM methods define the QA/QC procedures and analytical procedures to be used in the laboratory. The chemical laboratory QC checks are method specific and include but are not limited to, the following:

- Initial and continuing calibration verifications;
- Method blanks;
- Internal standards, surrogates, matrix and blank spikes; and
- Replicate analyses.

TABLE C.1
QC CRITERIA FOR FIELD ANALYSES AT
THE GROUP X4B(u) SITES

Matrix	Parameter	Field Duplicates	Field Blanks
Groundwater	pH	± 0.1 s.u.	NR
	conductivity	5% RPD	NR
	temperature	± 1.0 °C	NR
	turbidity	no criteria (record results) - due to natural turbidity fluctuations, measurements may not agree	< Reporting Limit
Surface Water	pH	± 0.1 s.u.	NR
	hardness	5% RPD	< Reporting Limit
Sediment	pH	NA	NR
Soil	pH	NA	NR
	non-selective VOCs	NA	< Reporting Limit

NR = not required

NA = not applicable, measurements are intended for qualitative screening.

TABLE C.2
INVESTIGATIVE AND QC SAMPLES FOR
THE GROUP X4B(U) SITES

Matrix	Analysis	Investigative Samples	Trip Blanks ⁽¹⁾	Rinseate Blanks	Field Duplicates	MS/MSD ⁽²⁾
Groundwater	VOCs	51	21	2	6	3
	Metals	51		2	6	3
Surface Water	VOCs	8	2		1	1
	SVOCs	8			1	1
	Metals	8			1	1
	Pesticides	8			1	1
	VOCs	8			1	1
Sediment	SVOCs	8			1	1
	Metals	8			1	1
	Pesticides	8			1	1
	Explosives	8			1	1
	TOC	8			1	
	Bioassay	8			1	

(1) One per cooler containing samples for VOC analyses.

(2) The value given is the number of MS/MSD pairs. The number of samples will be twice the value given.